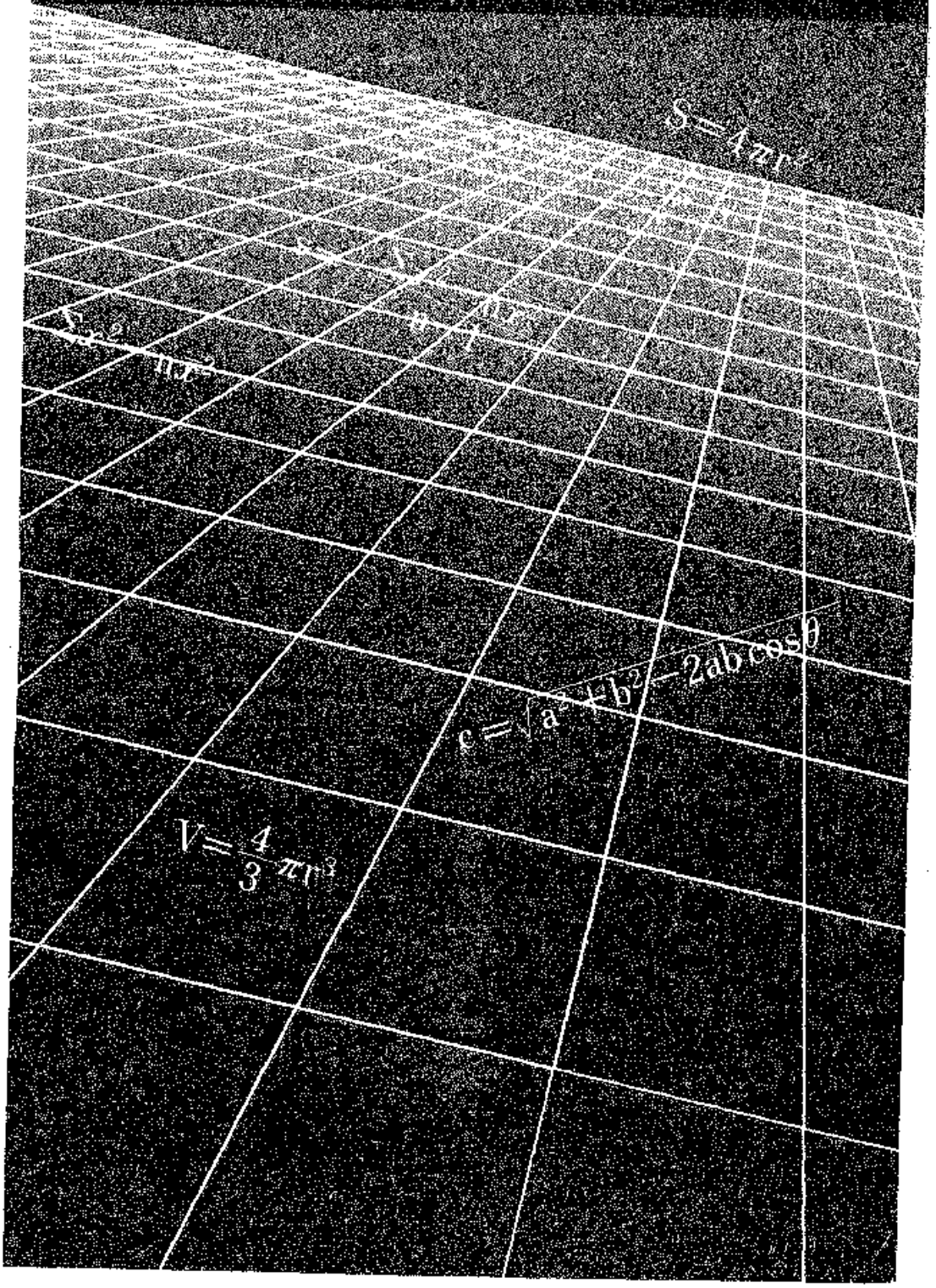
SHARP®

SCIENTIFIC CALCULATOR

MODEL

EL-512H

OPERATION MANUAL



NOTICE

- The contents of this manual are subject to change without notice for improvement.
- This calculator is provided with a combination of extremely sophisticated functions and has been shipped after thorough inspections including checks on the operations described in the Manual. Should you encounter any difficulties, contact your nearest SHARP distributor, dealer, or retailer. Your suggestions on the calculator are also invited.
- SHARP is not responsible for any monetary loss or loss of profits from the use of any of the calculation examples contained in this manual or for any claims from a third party.
- SHARP is not responsible for any loss, alteration, or damage to, the memory contents as a result of any defect, repair, or battery replacement of the calculator.

When Abnormal Conditions Cause a Malfunction

If the calculator is subjected to large external noises or severe shock while in use, all the keys might sometimes become inoperative. Should such an abnormal condition occur with this calculator, take the following step: (See Reset Switch on page 4.)

[1] Press the reset switch.
- "ALL CL?→ENT" will appear on the display.

[2] Press any key other than the [ENT] key.
- If the [ENT] key should be pressed, all the memory contents are lost.

The calculator can now perform calculations and the memory contents are retained.

If the memory contents have been changed due to large external noise or severe shock, the memory contents may have already been altered regardless of the reset operation.

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OPERATIONAL NOTES
Handling Recommendations

Because the LCD (liquid crystal display) of the calculator is made of a liquid crystal hermetically sealed between two glass plates, adequate caution must always be exercised when handling the calculator.

To ensure trouble-free operation of the calculator, please observe the following points:

1. Do not carry the calculator in the back pocket of slacks or trousers.
2. Do not drop the calculator or subject it to severe shock.
3. Do not operate any key with hard pointed objects or with excessive force. This practice may damage the keyboard or mark the surface.
4. Do not place the calculator in a location subject to direct sunlight, especially in a car with its window closed in hot climates. The calculator may be damaged by high temperatures.
5. Do not place the calculator in a location exposed to high temperatures (e.g., near a heater). Also avoid locations subject to rapid temperature changes and excessive moisture or dust.
6. Do not use any volatile solvent or water to clean the calculator. Always use a soft, dry cloth.

If service should be required on this unit, use only a SHARP servicing dealer, SHARP approved service facility, or SHARP repair service.

Chapter 1

Introduction

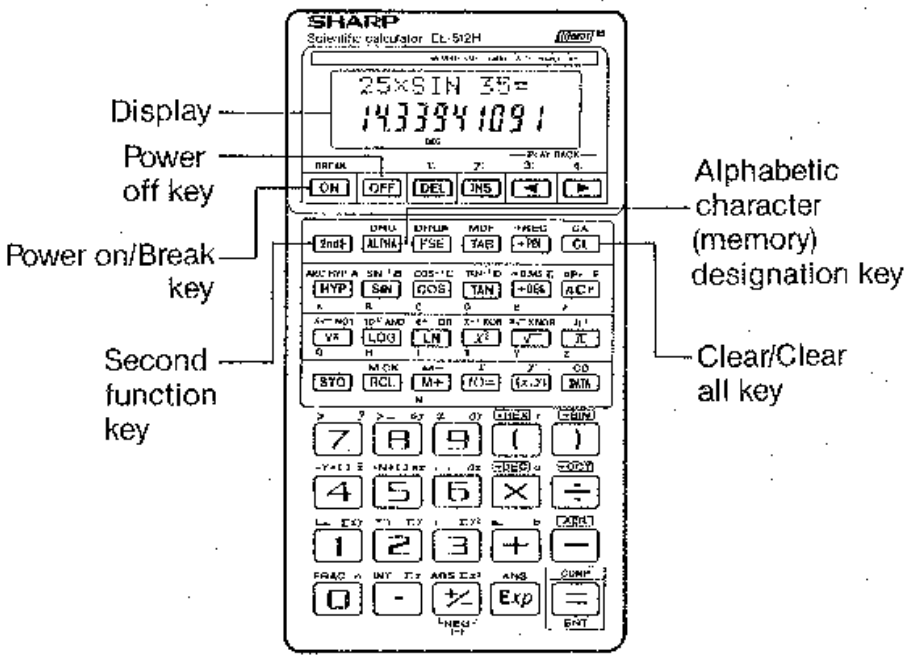
This chapter introduces you to the SHARP EL-512H Scientific Calculator, a new and powerful computing instrument. This chapter will provide a basic understanding of the calculator.

The calculator allows direct entry of calculations and expressions (or formulas) as written. As you follow the detailed instructions and calculation examples in Chapters 2 and 3 of the manual, you will find that you are not required to learn any machine or computer language with this calculator, yet it provides you with formidable power in mathematical, scientific, engineering, and business calculations.

The calculator features such unique functions as the algebraic expression reserve function, conditional expression decision and looping functions, and playback and answer memory functions. These important and useful functions are detailed in Chapters 2 and 3.

Other helpful information such as operating control, error conditions, etc. are included in the Appendixes for convenient reference.

Part Names



- Keyboards

  The keyboard consists of 50 keys. The five most frequently used are briefly introduced here to show you their functions and locations.

BREAK ON key ..... The key used to turn on the power for the calculator. This key is also used to interrupt the execution of an algebraic expression in the COMP mode.

OFF key ..... The key used to turn off the power for the calculator.

2nd F key ..... The function change key used to designate the second function of another key. The second function of the other key is printed in yellow above the key.

[ALPHA] key ..... The key used before the input of alphabet characters and statistics, etc.

[CA / CL] key ..... The clear/clear all key used to clear the contents of the display, memory, statistics and error conditions.

- Display

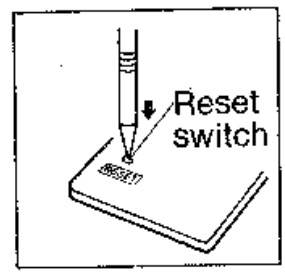
  The display consists of two lines, the upper line a 12 column 5 × 7 dot matrix liquid crystal display and the lower line a 12 column 7-segment display (10 digit mantissa and 2 digit exponent).

- Reset Switch

  The switch used to reset the calculator or erase memory contents. To press the reset switch, take the following steps:

  (1) Press the reset switch with a ball point pen.

  (2) "ALL CL?→ENT" will be displayed. To clear all the contents, press the [ENT] key. Otherwise, press any key other than the [ENT] key.



Auto-Power Off Feature

If no key is pressed for about 10 minutes, the power automatically turns off to conserve battery power. The memory is retained. To resume operation, press the [ON] key.

Operation Modes

The calculator operates in two basic modes: COMP, an abbreviation for Computation, and AER, an abbreviation for Algebraic Expression Reserve. The calculator normally operates in the COMP mode. To select the AER mode, press the 2nd F AER keys so that the AER indicator appears on the display. (Press the 2nd F AER keys again to turn to the COMP mode.)

COMP (computation) mode

The COMP mode is used to perform calculations. All calculations from arithmetic operations to memorized algebraic equations are performed in this mode. Although decimal calculations are normally used in the COMP mode, the BIN mode for binary calculations, the OCT mode for octal calculations and the HEX mode for hexadecimal calculations can also be specified. Furthermore, statistical calculations can be performed in the COMP mode.

AER (algebraic expression reserve) mode

The AER mode stores expressions such as algebraic equations. Store memories (A to I, M, X, Y, and Z) can be used as variables in the equations. When the AER indicator is displayed and the 2nd F AER keys are pressed, the AER indicator clears and the calculator is in the COMP mode.

Basic Operation

Key Operation

The calculator is provided with a wide variety of functions (including scientific, statistical and algebraic expression) as well as the four basic arithmetic (add, subtract, multiply, and divide) functions. Here, the procedural steps in performing the basic calculations are briefly covered before the details are described in later chapters.

(1) Power On

As mentioned earlier, you will find the [ON] key at the top of the keyboard. Press this key to turn on the calculator.

(2) Operation Mode Selection

This calculator has two operation modes; COMP (computation); and AER (algebraic expression reserve). Normally, the calculator operates in the COMP mode. This mode allows the calculator to perform all computations and calculations, including statistics. The AER mode allows the calculator to store algebraic expressions in memory. The calculator is put in the AER mode by pressing the [2nd F] and [AER] keys. The AER indicator will appear in the lower right display to indicate the AER mode is selected. To return to the COMP mode, press the [2nd F] and [AER] keys again, the AER indicator will disappear. Each time the [2nd F] and [AER] keys are pressed the AER indicator will toggle on/off. If the AER indicator is not displayed, the calculator is in the COMP mode.

(3) Add, Subtract, Multiply, and Divide Functions

To perform any of the four basic functions with this calculator, enter the numeric data and press the algebraic keys ([+], [−], [×], [÷], [=]) in the same sequence as you would with any other scientific calculator. If the BIN, OCT, or HEX indicator is displayed, first press the Reset Switch and then the [CL] key before performing the examples below.

Example 1: To calculate 123+654

Key in:

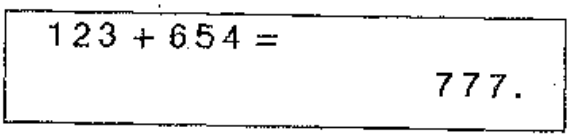
[1] [2] [3] [+]

Key in:

[6] [5] [4]

Key in:

[=]



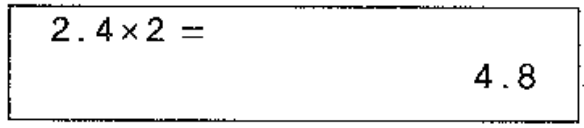
Example 2: To calculate 2.4 × 2

Key in:

[2] [.] [4] [×] [2]

Key in:

[=]



If you make an error in a key sequence and an error message appears in the display, press the [CL] key to clear the data, then enter the data again in the correct sequence. If you wish to correct the incorrect sequence, use the [◄] or [►] key to move the cursor to the incorrect entry on the display and then enter the correct data. You may need to use the [DEL] and [INS] keys. (See Appendix A for Key Functions and Appendix D for Error Conditions and Messages.)

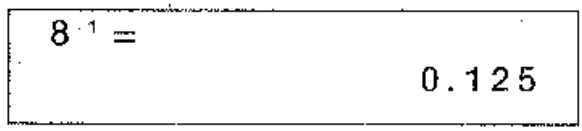
(4) Scientific Functions

As an example for scientific functions, we will solve for the reciprocal of a number using the Reciprocal ([x^{-1}]) key.

Example: To solve $\frac{1}{8}$ =(or 8^{-1}=)

Key in:

[8] [2nd F] [x^{-1}] [=]



Note:

[x^{-1}] is the second function of the [x^2] key and is activated by pressing the [2nd F] key, then the [x^2] key.

Key Functions

With this calculator, most of the keys have three functions, some keys have four, and others only two or one. The function printed on the key itself occurs when you press that key only. The function printed in yellow above a key is the second function of that key, and becomes effective only when the key is pressed following the function change key (2nd F), as you have just done in the above calculation example.

Note:

The function labeled ENT below the COMP = ENT key and the functions labeled NEG below the ABS Σx^2 +/− NEG (−) key are not the second functions of these keys.

Functions labeled x', y' and CD above the $\hat{x}(\bar{x})$ =, $\hat{y}'(\bar{x}, \bar{y})$, and CD DATA keys are those used for statistical calculations. The functions marked in blue right above keys (such as $\bar{y}$ and s_y) are used in statistical calculations. To use the statistical functions in calculations, press the RCL key and then the statistical key and the value now held in the statistical memory will be displayed. To use future statistic values, write expressions which include the ALPHA key and the statistical key, and that current rate will be calculated.

Keys such as HYP and SIN, with blue letters (A to I, M, X, Y, Z) labeled to their left bottom, function as store memories when the key is pressed after STO or RCL. If pressed after the ALPHA key, the respective alphabetic character is displayed. Alphabetic characters are usually used as variables for algebraic expressions.

Note:

Memory M is also used as the independent memory.

Functions labeled in black to the right above the [ARC HYP A] [HYP], [SIN⁻¹ B] [SIN], [COS⁻¹ C] [COS], [TAN⁻¹ D] [TAN], [→DMS E] [→DEG] and [nPr F] [nCr] keys are those used for entry of hexadecimal numbers in the HEX mode.

Functions labeled NOT, AND, OR, XOR, and XNOR in black to the right above the [x√ NOT] [Y^x], [10^x AND] [LOG], [e^x OR] [LN], [x⁻¹ XOR] [x²] and [3√ XNOR] [√‾] keys are those used to perform logical operations of binary, octal, and hexadecimal numbers in the respective number modes.

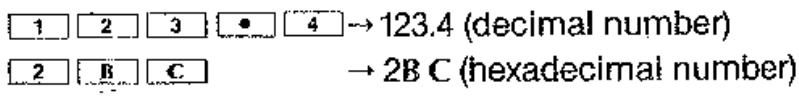
Note:
To distinguish the multiply command × and letter X (*x*), this manual uses the characters below.

	Key	Display
letter	[*x*]	X
multiply	[×]	×

Conventions for Key Entry
In the following Chapters, whenever possible key operations and key functions are described as shown in the following examples.

Key	Key operation	Designated function
[SIN⁻¹ B] [SIN] B	[2nd F] [SIN⁻¹]	SIN^{-1}
	[B]	Hexadecimal number B
	[SIN]	SIN
	[ALPHA] [B]	Alphabet B
[x√ NOT] [Y^x] G	[2nd F] [x√‾]	$\sqrt[x]{\ }$
	[NOT]	Logical NOT
	[Y^x]	Y^x
	[ALPHA] [G]	Alphabet G

From here, numeric keys for data entry are not enclosed in a box.



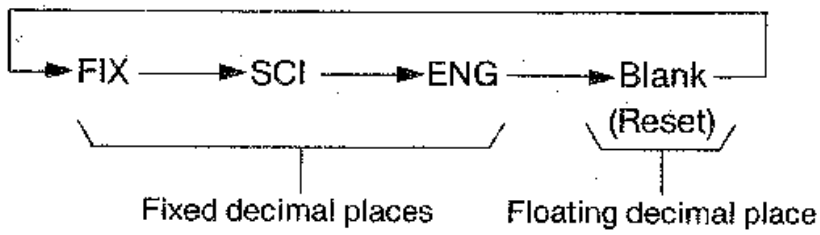
The word "key in" or "press" before each key operation is omitted when self-explanatory.

Display Modes

This calculator has four different display modes which can be selected with the [FSE] (display mode control) key.

In each of the display modes, 10 digits is the maximum number of significant digits carried into the next calculation.

When you press the [FSE] key during calculations with decimal numbers, the display mode indicator "FIX", "SCI", or "ENG" or a blank (i.e., none of these) will appear in the lower part of the display.
The [FSE] key is operative only after the result of a calculation has been displayed, or when the calculator is cleared with the [CL] key, etc.



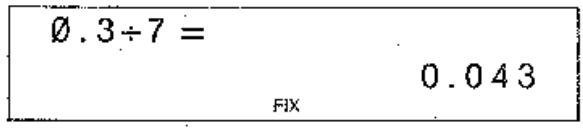
The designated notation and decimal places will be retained even when the calculator is turned off.

(1) FIXed decimal point notation (FIX)

Set the number of decimal places using the [TAB] key. Each calculation result is displayed with the chosen number of decimal places and the last digit is rounded off.

Example:

[CL] [FSE] (To display FIX indicator)
[TAB] 3 (To fix the number of decimal places to 3)
0.3 [÷] 7 [=]



(2) SCIentific notation (SCI)

Each calculation result is displayed with scientific notation ($A \times 10^B$). The mantissa part of the calculation result is displayed in accordance with the decimal place designation (TAB) and the final digit of the mantissa part is automatically rounded off.

Example:

[CL] [FSE] (To display the SCI indicator)
[TAB] 2 (To fix the number of decimal places to 2)
0.3 [÷] 7 [=]

The above display means that the number of significant digits has been fixed to 3.

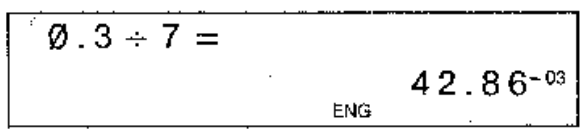
(3) ENGineering notation (ENG)

Each calculation result is displayed in scientific notation ($A \times 10^B$). At this time its mantissa is displayed according to the decimal place designation (TAB) and the exponent is automatically set to a multiple of 3 (...., -6, -3, 0, 3, 6,....) for display. Therefore, any display can be easily read in units of k (kilo-10^3) or m (milli-10^{-3}), etc., that is commonly used in the engineering field.

(The last next digit in the specified number of decimal places is automatically rounded off.)

Example:

[CL] [FSE] (To display ENG indicator)
[TAB] 2 (To fix the number of decimal places to 2)
0.3 [÷] 7 [=]



(4) Floating decimal place notation (Blank)

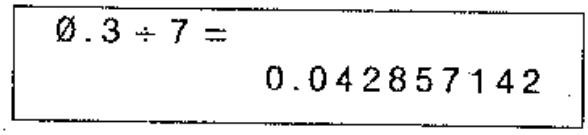
- None of FIX, SCI or ENG is displayed.
- Each calculation result is displayed in floating decimal point notation.

Calculation result x is displayed in scientific notation if it is not zero, or outside the range of $0.000000001 \leqq |x| \leqq 9999999999$.

Example:

[CL] [FSE] (To clear the FIX, SCI and ENG indicators)

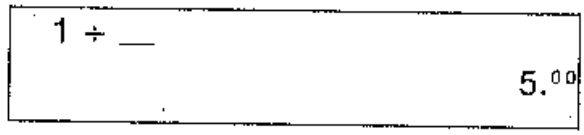
0.3 [÷] 7 [=]



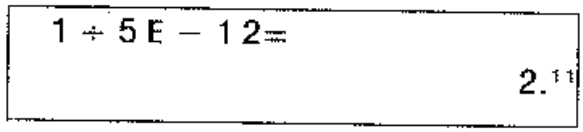
- When the calculation result exceeds 10 digits.

Example: $1 \div 5^{-12} =$

[CL] 1 [÷] 5 [Exp]



12 [+/−] [=]



Decimal Places

The [TAB] key is used to specify the number of decimal positions in a calculation result when the FIX, SCI, or ENG Mode is set. The number of decimal places is specified by a numeral key ([0] to [9]) following the [TAB] key. Carry-over will be automatically rounded. Use the [TAB] key when the calculation result is displayed or when the calculator is cleared with the [CL] key.

Example:
Set decimal places when FIX Mode is designated.

[CL] [FSE] (To display FIX indicator)
[TAB] 9 (To fix the number of decimal places to 9)
5 [÷] 9 [=]

```
5 ÷ 9 =
              0.555555556
                  FIX
```

[TAB] 8 (To fix the number of decimal places to 8)

```
5 ÷ 9 =
               0.55555556
                  FIX
```

⋮

[TAB] 0 (To fix the number of decimal places to 0)

```
5 ÷ 9 =
                        1.
                  FIX
```

Notes:

1. In the FIX mode, the designated number of decimal places may not be displayed if there are too many integer digits (e.g., when calculating 100÷3 with the number of decimal places set to 9 by pressing [TAB] 9, the displayed result is 33.33333333 or only 8 decimal places.)
2. The designated number of decimal places is retained even when the display mode is changed or when the power is turned off.

Indicators

With this calculator, the following indicators may appear in the lower part of the LCD screen.

Indicators

←	Indicates that information (a portion of an expression or formula that has already been displayed) exists to the left of the information now on the display.
→	Indicates that information yet to be displayed exists to the right of the information now on the display.
2ndF	Indicates that the second function of a key has been specified.
ALPHA	Indicates that the calculator is in the ALPHA (alphabetical character input) mode.
HYP	Indicates that the hyperbolic function has been specified.
DEG	Indicates that degrees is used as the angle unit for the calculation.
RAD	Indicates that radians is used as the angle unit for the calculation.
GRAD	Indicates that gradient is used as the angle unit for the calculation.

FIX — Indicates that the result of a calculation is displayed in fixed decimal point notation.

SCI — Indicates that the result of a calculation is displayed in scientific notation.

ENG — Indicates that the result of a calculation is displayed in engineering notation.

BIN — Indicates that the calculator is in the BIN (binary number) mode and that the displayed number is a binary number.

OCT — Indicates that the calculator is in the OCT (octal number) mode and that the displayed number is an octal number.

HEX — Indicates that the calculator is in the HEX (hexadecimal number) mode and that the displayed number is a hexadecimal number.

AER — Indicates that an algebraic equation can be entered (AER mode).

Chapter 2
COMP Mode

Before performing the calculation examples in this chapter, check the calculator is in the COMP mode (make sure AER is not displayed, if it is, press 2nd F AER until it disappears) and then press the 2nd F CA keys to clear the calculator. Unless otherwise stated, all the following calculation examples are to be performed in the floating decimal point mode. If FIX, SCI, or ENG indicators appears in the display, press the FSE key repeatedly until they clear, this indicates that the calculator is in the floating decimal point mode.

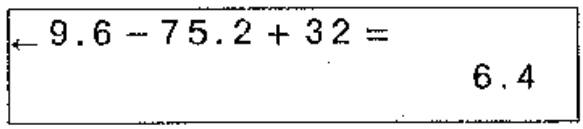
Addition, Subtraction, Multiplication, and Division

Examples shown here are mixed calculations of the four basic functions.

Note:
This calculator uses algebraic logic. Calculations are not necessarily performed in the order entered. For example, multiplication is carried out before addition. Priority levels in calculations are detailed in Appendix E.

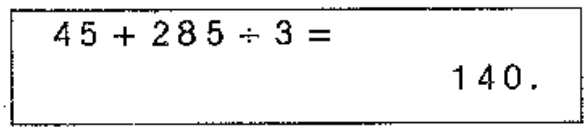
Example 1:
49.6 − 75.2 + 32 =

[CL] 49.6 [−] 75.2 [+] 32 [=]



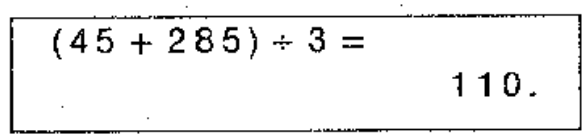
Example 2:
45 + 285 ÷ 3 =

45 [+] 285 [÷] 3 [=]



Example 3:
(45 + 285) ÷ 3 =

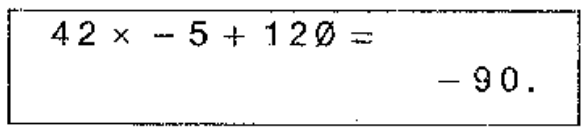
[(] 45 [+] 285 [)] [÷] 3 [=]



Note:
The parenthesis keys specify which group of numbers to calculate first whenever there is a choice. If you omitted parentheses, your answer would be 140 as in Example 2 because division takes precedence over addition. (See Appendix E for details on Priority Levels in Calculations.)

Example 4:
$42 \times (-5) + 120 =$

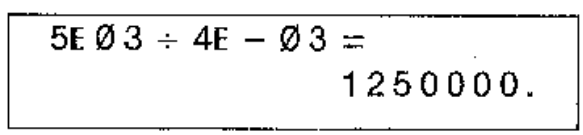
42 [×] 5 [+/−] [+] 120 [=]



Note:
When you enter a negative number, as in Example 4, press [+/−] after the negative number.

Example 5:
$(5 \times 10^{3}) \div (4 \times 10^{-3}) =$

5 [Exp] 3 [÷] 4 [Exp] 3 [+/−] [=]



Note:
[Exp] is used to enter the exponent part of a number.

Example 6:

$72 \times (((56+23) \times 2) - 72 \div 4) =$

72 [(] [(] [(] 56 [+] 23 [)] [×] 2 [)]

①

[−] 72 [÷] 4 [=]

②

```
(( 23) × 2) − 72 ÷ 4 =
                    10080.
```

Notes:

(1) The multiply key immediately before the open parenthesis may be omitted, as shown by ① above.

(2) The close parenthesis before the equals key may be omitted, as shown by ② above. The close parenthesis may also be omitted before the following keys: [STO], [M+], [2nd F] [M−], [2nd F] [→DEC], [2nd F] [→BIN], [2nd F] [→OCT], [2nd F] [→HEX]

(3) Multiple parentheses may be entered in an expression with other calculation commands for complicated arithmetic sequences, provided that the number of pending operations in the calculator does not exceed 16 and the number of pending values in the calculator does not exceed 8. (See Appendix E for details on Pending Operations.)

Scientific Functions

Scientific calculations are performed in the same manner as basic calculations. As you will note in the following examples, scientific functions are entered as you would normally read them.

Trigonometric Functions

When you solve for any of the trigonometric and inverse trigonometric functions; you must first designate the angle unit applicable to the function using the 2nd F and DRG keys. As these two keys are pressed repeatedly, the indications "DEG", "RAD", and "GRAD" appear alternately in the lower part of the display. Keep pressing 2nd F DRG until the desired unit of angle is set on the display.

DEG: Degree [°]
RAD: Radian [RAD]
GRAD: Gradient [g]
90[°] = $\frac{\pi}{2}$ [RAD] = 100 [g]

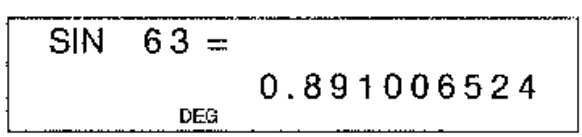
Note:

The designated angle unit will be retained in memory even when the power is turned off; you need not designate the unit each time the power is turned on.

Example 1:

SIN 63 =
Angle unit: DEG

SIN 63 =

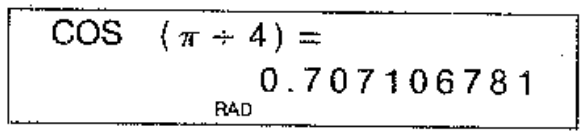


Example 2:

$\cos\frac{\pi}{4}$ =

Angle unit: RAD

[COS] [(] [π] [÷] 4 [)] [=]



Note:

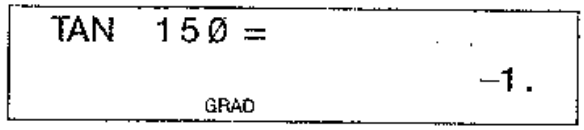
To solve an expression such as $\cos\frac{\pi}{4}$, parenthesize the expression.

Example 3:

TAN150=

Angle unit: GRAD

[TAN] 150 [=]



Inverse Trigonometric Functions

The calculation results of the respective inverse trigonometric functions are expressed within the following limits.

$\theta=\sin^{-1}x, \theta=\tan^{-1}x$	$\theta=\cos^{-1}x$
DEG: $-90 \leqq\theta\leqq 90$	DEG: $0\leqq\theta\leqq 180$
RAD: $-\frac{\pi}{2} \leqq\theta\leqq\frac{\pi}{2}$	RAD: $0\leqq\theta\leqq\pi$
GRAD: $-100\leqq\theta\leqq 100$	GRAD: $0\leqq\theta\leqq 200$

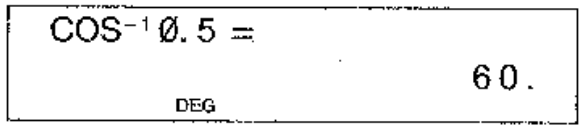
In addition to the designation of the angle unit using the [2nd F] and [DRG] keys, you must use the [2nd F] key for each calculation example to designate the second function of other keys.

Example 1:

$COS^{-1}0.5=$

Angle unit: DEG

[2nd F] [COS^{-1}] .5 [=]

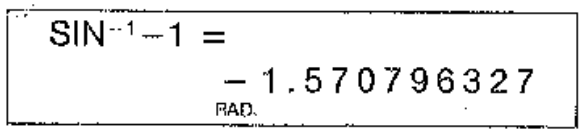


Example 2:

$SIN^{-1}-1$ =

Angle unit: RAD

[2nd F] [SIN^{-1}] 1 [+/−] [=]

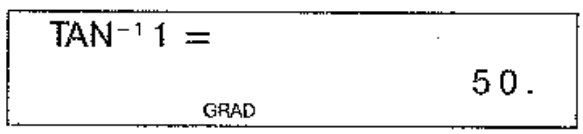


Example 3:

$TAN^{-1}1=$

Angle unit: GRAD

[2nd F] [TAN^{-1}] 1 [=]



Hyperbolic and Inverse Hyperbolic Functions

When using any of the hyperbolic and inverse hyperbolic functions, the "HYP" indicator will appear briefly in the lower part of the display.

Example 1:

SINH4=

[HYP] [SIN] 4 [=]

```
SINH   4 =
                27.2899172
```

Example 2:

$(\text{COSH}1.5+\text{SINH}1.5)^2=$

[(] [HYP] [COS] 1.5 [+] [HYP] [SIN] 1.5 [)] [x^2] [=]

```
← + SINH   1.5)² =
                20.08553692
```

Example 3:

$\text{SINH}^{-1}9=$

[2nd F] [ARC HYP] [SIN] 9 [=]

```
SINH⁻¹9 =
                2.893443986
```

Example 4:

$\text{TANH}^{-1}\frac{5}{7}=$

[2nd F] [ARC HYP] [TAN] [(] 5 [÷] 7 [)] [=]

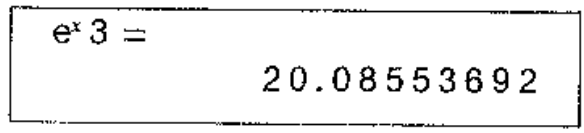
```
TANH⁻¹(5 ÷ 7) =
                0.895879734
```

Exponential Functions

Example 1:

$e^3 =$

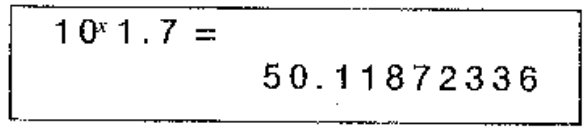
[2nd F] [e^x] 3 [=]



Example 2:

$10^{1.7} =$

[2nd F] [10^x] 1.7 [=]

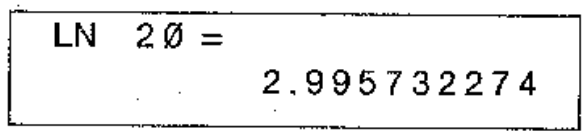


Logarithmic Functions (Natural and Common Logarithms)

Example 1:

LN20=

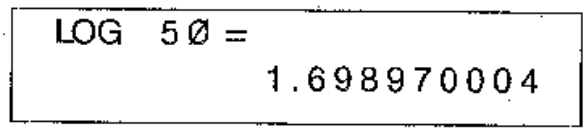
[LN] 20 [=]



Example 2:

LOG50=

[LOG] 50 [=]



Squaring

Example:

$5^2 - 4^2 =$

5 [x^2] [−] 4 [x^2] [=]

Reciprocals

Example:

$\frac{1}{8} =$

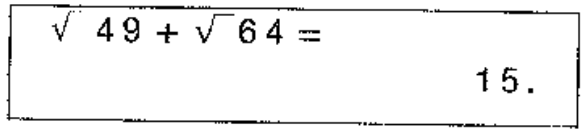
8 [2nd F] [x^{-1}] [=]

Square Root and Cubic Root

Example 1:

$\sqrt{49} + \sqrt{64} =$

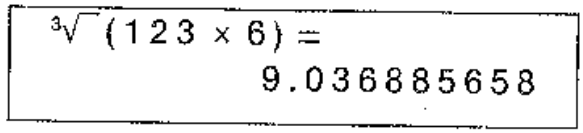
[$\sqrt{}$] 49 [+] [$\sqrt{}$] 64 [=]



Example 2:

$\sqrt[3]{123 \times 6} =$

[2nd F] [$\sqrt[3]{}$] [(] 123 [×] 6 [)] [=]

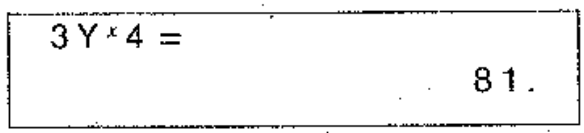


Power

Example 1:

$3^4 =$

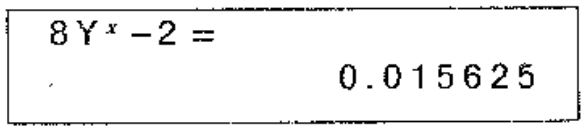
3 [Y^x] 4 [=]



Example 2:

$8^{-2} =$ (or $\frac{1}{8^2} =$)

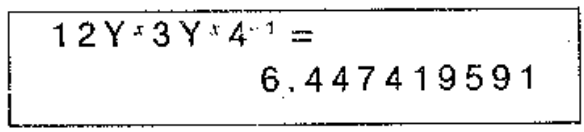
8 [Y^x] 2 [+/-] [=]



Example 3:

$(12^3)^{\frac{1}{4}} =$ (or $\sqrt[4]{12^3} =$)

12 [Y^x] 3 [Y^x] 4 [2nd F] [x^-1] [=]



Power Root

Example:

$\sqrt[4]{81} =$

4 [2nd F] [x√] 81 [=]

Factorial

Example:

$6!=(6\times5\times4\times3\times2\times1=)$

6 [2nd F] [n!] [=]

Permutations

Formula:

$$nPr=\frac{n!}{(n-r)!}$$

Example:

From a group of 10 persons, you must decide how many combinations of 3 persons can be lined up. What is the total number of ways different groups of 3 can be arranged?

10 [2nd F] [nPr] 3 [=]

Combinations

Formula:

$$nCr = \frac{n!}{r!(n-r)!}$$

Example:

You must select 3 persons from a group of 10. How many different combinations of 3 persons can be formed?

10 [nCr] 3 [=]

10 C 3 =
120.

Conversions of Coordinates

Two keys are used for conversions of coordinates.

[→POL]: Converts rectangular coordinates (x, y) into polar coordinates (r, θ).

[2nd F] [→REC]: Converts polar coordinates (r, θ) into rectangular coordinates (x, y).

Note:

The calculation results for the coordinate conversion are stored in storage memories X and Y.

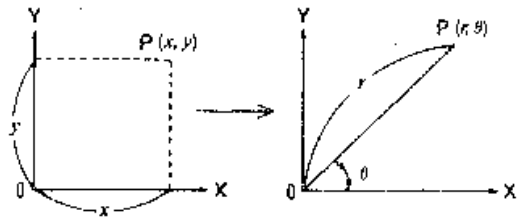
Memory / Calculation	X	Y
→POL	r	θ
→REC	x	y

Note:

When a coordinate conversion is performed, any values in storage memories X and Y are replaced.

- Conversion of rectangular coordinates into polar coordinates ($x, y \rightarrow r, \theta$)
  The value of θ is obtained within the following limits:

DEG : $0 \leq |\theta| \leq 180$
RAD : $0 \leq |\theta| \leq \pi$
GRAD: $0 \leq |\theta| \leq 200$

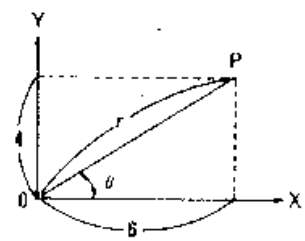


$$r = \sqrt{x^2 + y^2},\ \theta = \mathrm{TAN}^{-1}\frac{y}{x}$$

Before you start the conversion, press the [2nd F] and [DRG] keys to designate the desired angle unit.

Example 1:

To obtain the polar coordinates (r, θ) from the rectangular coordinates (x, y) for point P (6, 4)
Angle unit: DEG



6 [→POL] 4 [=]

```
6 → POL   4 =
                7.211102551
DEG
```

(Answer for r)

[RCL] [Y] (or [ALPHA] [Y] [=])

```
Y =
                33.69006753
DEG
```

(Answer for θ)

Example 2:

To obtain the magnitude (r) and direction (phase) of vector a on a complex plane, where $a=12+9i$ ($i=\sqrt{-1}$).

Angle unit: DEG

12 [→POL] 9 [=]

```
12 → POL   9 =
                        15.
DEG
```

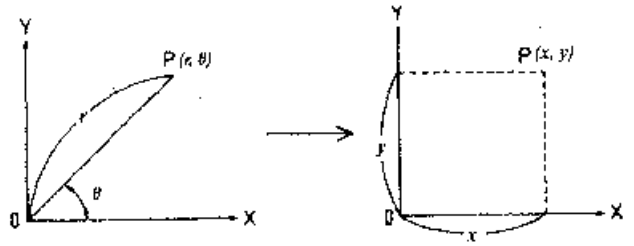
(Answer for magnitude)

[RCL] [Y] (or [ALPHA] [Y] [=])

```
Y =
                 36.86989765
DEG
```

(Answer for direction)

- Conversion of polar coordinates into rectangular coordinates ($r, \theta \rightarrow x, y$)

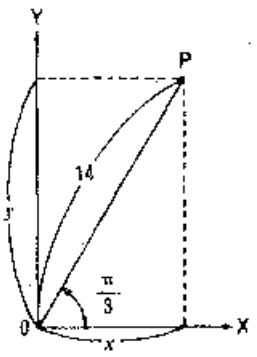


$x=r\cos\theta$, $y=r\sin\theta$

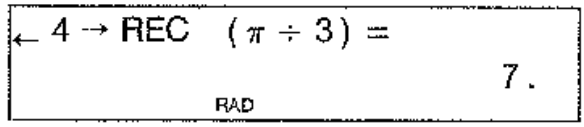
Example:

To obtain the rectangular coordinates (x, y) from the polar coordinates (r, θ) at point P $(14, \frac{\pi}{3})$

Angle unit: RAD

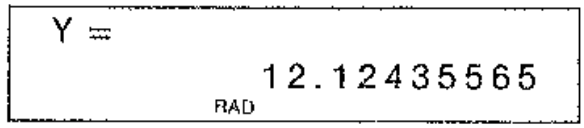


14 [2nd F] [→REC] [(] [π] [÷] 3 [)] [=]



(Answer for x)

[RCL] [Y] (or [ALPHA] [Y] [=])



(Answer for y)

Conversions of Angles

- Angular Unit Conversion

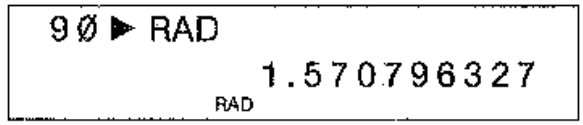
[DRG▶] Converts the displayed angular unit to another unit. Each time [2nd F] [DRG▶] are pressed, the unit is converted in the order of DEG→RAD→GRAD.

Example:

Convert degree (90°) to radian.

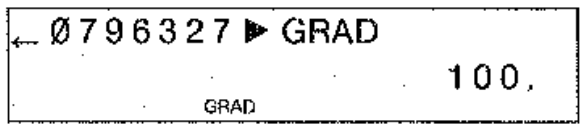
Angle unit: DEG

90 [2nd F] [DRG▶]



Convert to gradian.

[2nd F] [DRG▶]



Convert to degree.

2nd F DRG▶

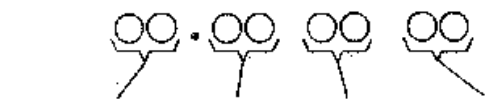
```
100 ▶ DEG
                          90.
DEG
```

Sexagesimal/Decimal Angle Conversion

Two keys are used for conversions between sexagesimal and decimal angle.

→DEG: Converts a sexagesimal angle (in degrees, minutes, and seconds) into its decimal equivalent (in degrees).

2nd F →D.MS: Converts a decimal angle (in degrees) into its sexagesimal equivalent (in degrees, minutes, and seconds).



- In this case, the fraction part of a calculation result is displayed in six digits after rounding the digit in the 7 decimal place (regardless of the FSE and/or TAB setting).

Example 1:

To convert 12°39′18″ into its decimal equivalent

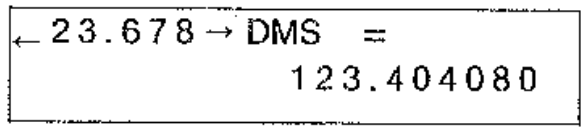
12.3918 →DEG =

```
← 2.3918 → DEG  =
                    12.655
```

Example 2:

To convert 123.678° into its sexagesimal equivalent

123.678 [2nd F] [→D.MS] [=]



(123° 40′ 40″ 80)

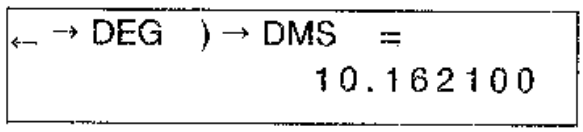
- Time calculations

  This calculator can also perform time calculations using the above angle conversion function.

Example 3:

3 hours 30 minutes 45 seconds
+)6 hours 45 minutes 36 seconds
(total?)

[(] 3.3045 [→DEG] [+] 6.4536 [→DEG] [)] [2nd F] [→D.MS] [=]



(10 hours 16 minutes 21 seconds)

Other Functions

- FRAC (Fraction)

  The FRAC function is used to display the fraction part of a number.

Example:

To find the decimal fraction part of the result of division 58 ÷ 8

2nd F FRAC (58 ÷ 8) =

```
FRAC  (58 ÷ 8) =
                    0.25
```

- INT (Integer)

  The INT function is used to display the integer part of a number.

Example:

To find the integer part of the result of the division 58 ÷8

2nd F INT (58 ÷ 8) =

```
INT  (58 ÷ 8) =
                    7.
```

- ABS (Absolute value)

  The ABS function is used to determine the absolute value of a number.

Example:

To find the absolute value of log 0.75

2nd F ABS (LOG .75) =

```
←(LOG  Ø.75) =
              0.124938736
```

Playback Function

The playback function recalls the most recent calculation. This is useful when you wish to confirm or correct your last calculation. This function is particularly useful for finding the location of an error which occurred during the execution of a calculation and increases efficiency in error processing.
The [◄] and [►] keys are used for the playback function.

Example 1:

To correct the expression from 5 ÷ 13 = to 15 ÷ 3 =

[CL] [FSE] (The display is in floating decimal point notation.)

5 [÷] 13 [=]

```
5÷13=
              0.384615384
```

[►]

```
5 ÷13=
```

└ Cursor blinks.

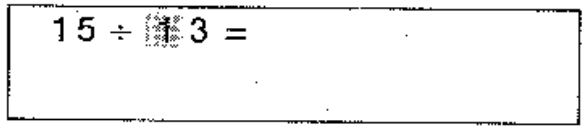
When the [►] or [◄] key is pressed, the cursor blinks at the beginning or the end of the expression, respectively.

[INS]

Cursor blinks.

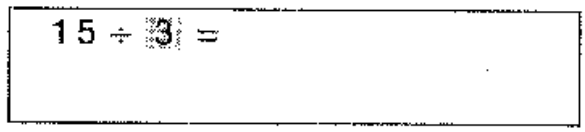
When the [INS] key is pressed, the displayed expression including the cursor shifts to the right by one column. An insert symbol ( ) is displayed at the empty column created.

1 [►] [►]



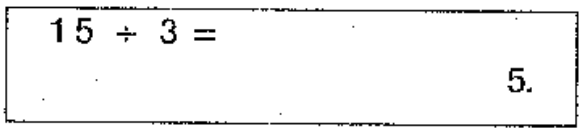
Cursor blinks.

[DEL] (This key deletes the character at the cursor.)



Cursor blinks.

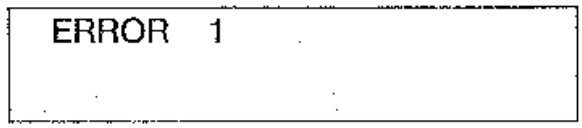
[=]



Example 2:

To find the location of an error in calculation (when 15 ÷ + 3 = is calculated instead of 15 ÷ 3 =).

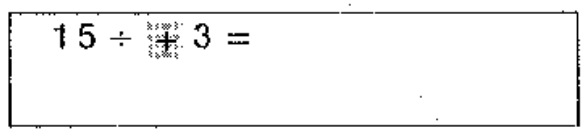
15 [÷] [+] 3 [=]



↑ Error code (see APPENDIX D)

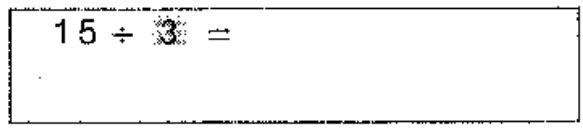
If an error occurs as shown above, press the [►] or [◄] key to locate the error.

[►] (or [◄])



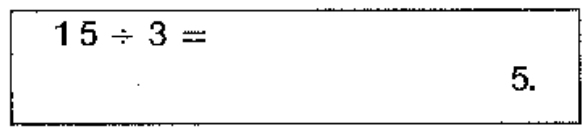
↑ Cursor blinks.

[DEL]



↑ Cursor blinks.

[=]



Answer Memory Function

In the COMP mode, calculation results obtained with any of the operation execution keys ([=], [M+], [2nd F] [M−], [STO] [A] to [STO] [I], [STO] [M], [STO] [X], [STO] [Y], [STO] [Z], [→BIN], [→OCT], [→HEX], [→DEC]) are automatically stored in the answer memory in the same way as results of programmed calculations executed by the [COMP] key. The value currently held in the answer memory (i.e., the result of the last computation) can be inserted into any position of the next algebraic expression by using the [2nd F] and [ANS] keys.

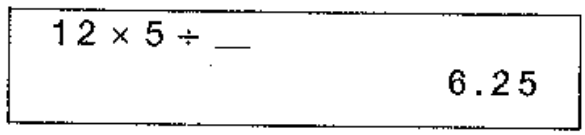
Example:

To calculate 12 × 5 ÷ 6.25 + 24 × 3 ÷ 6.25 =, where 6.25 is the result of the division 50 ÷ 8 = previously performed

[CL] 50 [÷] 8 [=]

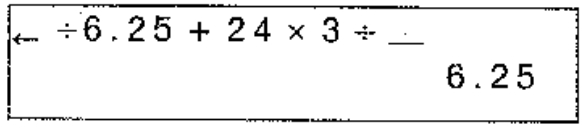
(Automatically stored in memory)

12 [×] 5 [÷] [2nd F] [ANS]



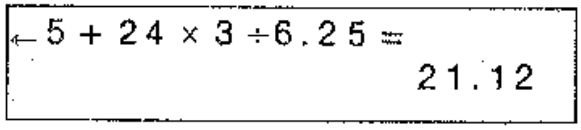
(Recalled from answer memory)

[+] 24 [×] 3 [÷] [2nd F] [ANS]



(Recalled from answer memory)

[=]



The last answer can also be recalled by pressing [RCL] [ANS] instead of [2nd F] [ANS]. If [ALPHA] [ANS] are pressed, ANS can be written into the expression and the last answer is recalled when the expression is calculated.

- While the value of the answer memory may be recalled as many times as required, it will be updated whenever any of the operation execution keys is used.

- When an attempt to calculate a manually entered expression results in an error, the result of the calculation executed immediately before the expression is retained in memory as the last answer.

- The contents of the answer memory will not be cleared even when; the calculator enters the Auto Power Off state, is turned off with the [OFF] key or when the [CL] key or [2nd F] and [CA] keys are operated.

Continuous Calculation and Modify Functions

Continuous Calculation Functions

This function enables a result obtained from a calculation to be used in the next calculation. The maximum number of significant digits (10 digits) is used for the next calculation, regardless of display system or number of decimal places.

Example:

To solve 3 + 4 = and then multiply the calculation result by 5

[CL] 3 [+] 4 [=]

```
3 + 4 =
                    7.
```

[×]

```
7 × __
                    0.
```

(Multiply command is input following the result of addition)

5 [=]

```
7 × 5 =
                   35.
```

Note:
This function varies from the answer memory function in that the result of the last calculation can be used only at the beginning of the following calculation.

Modify Function
This function enables the displayed calculation result or memory value to be used in an equation. With this calculator, the result of a calculation is obtained with accuracy of up to 12 digits for the mantissa, while all the internal calculations are in the exponential form ($A \times 10^B$). The results of all the internal calculations are displayed on the LCD after being converted into the form designated by the display mode (FIX, SCI, or ENG) and the number of decimal places set by TAB. The use of this modify function allows you to use the calculation result in the display (without change) for the next calculation. This function is very useful when you must perform calculations where the significant digits of a number are important, as in testing or processing the results of experiments. This function can be also used while entering an equation.

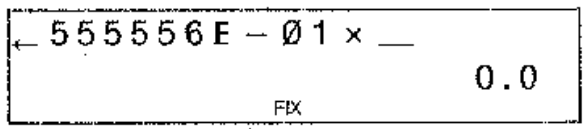
Example 1:
To solve 5 ÷ 9 = and then multiply the calculation result by 9

[FSE] (To display the FIX indicator)
[TAB] 1 (To fix the number of decimal positions to 1)

- Normal calculation

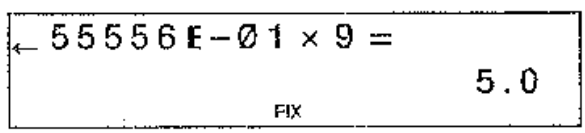
5 [÷] 9 [=]

[×]



(Result of internal calculation)

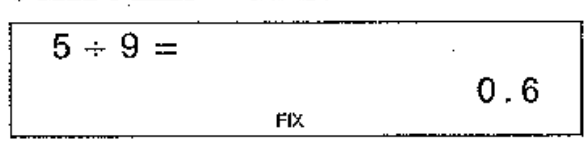
9 [=]



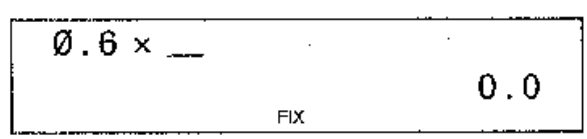
Note:
In continuous calculations such as this example, the value in the display is not used for the calculation. Instead, the value stored in memory is used.

- Calculation with modify function

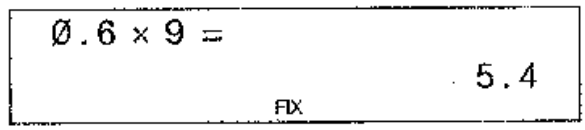
5 [÷] 9 [=] [2nd F] [MDF]



[×]



9 [=]



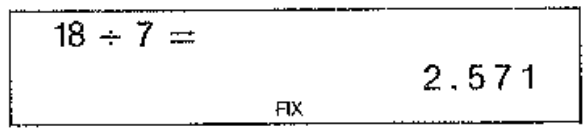
Example 2:

To multiply the result of 18 ÷ 7= by 5 and then double it.

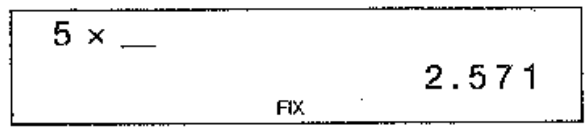
[FSE] (To display the FIX indicator)
[TAB] 3 (To fix the number of decimal positions to 3)

- Normal calculation

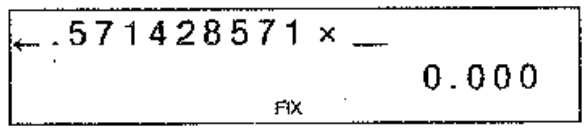
18 [÷] 7 [=]



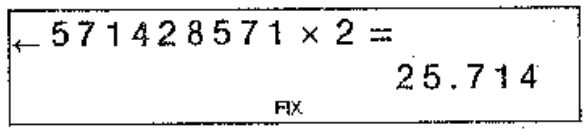
5 [×] [2nd F] [ANS]



[×]



2 [=]

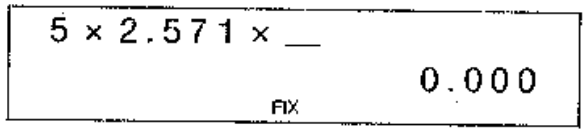


- Calculation with modify function

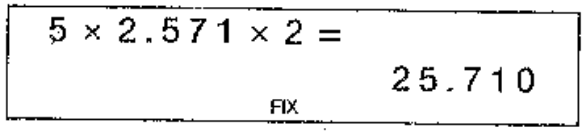
18 [÷] 7 [=]

5 [×] [2nd F] [ANS]

[2nd F] [MDF] [×]



2 [=]



Memory Calculations

This calculator has 13 memories; one used as an independently accessible memory or store memory and 12 as store memories only.

Independently Accessible Memory (M)

- How to use memory

Data movement in and out of memory is effected by the following memory control keys:

[STO]: Stores the result of a calculation in memory.
[RCL]: Recalls the memory contents.
[M+]: Adds the results of a calculation to the memory contents.
[2nd F] [M−]: Subtracts the results of a calculation from the memory contents.

- Clearing memory

Before you start the memory calculation in Example 1, you must either press both the [CL] and [STO] [M] keys to clear the memory contents or the [STO] [M] keys to enter the initial data in the memory.

Example 1:

[CL] [STO] [M]

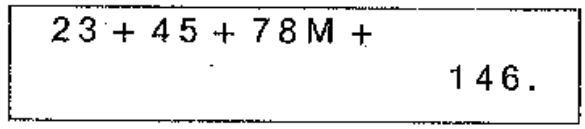
[FSE] (Press until FIX, SCI, and ENG indicators disappear)

Ø ⇒ M
0.

(Memory clear)

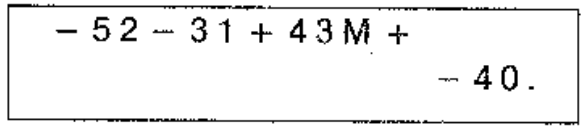
$$
\begin{array}{rl}
 & 23 + 45 + 78 = \ldots (1) \\
 & -52 - 31 + 43 = \ldots (2) \\
+) & 64 + 73 - 12 = \ldots (3) \\
\hline
 & \text{(total)} \quad \ldots (4)
\end{array}
$$

23 [+] 45 [+] 78 [M+]



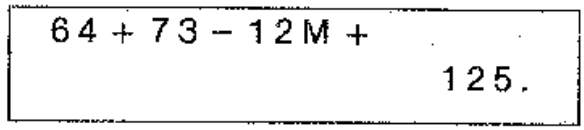
Answer for (1)

52 [+/-] [−] 31 [+] 43 [M+]



Answer for (2)

64 [+] 73 [−] 12 [M+]



Answer for (3)

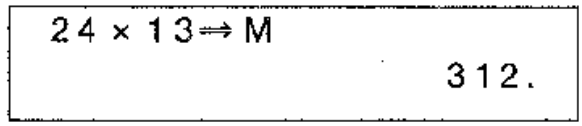
[RCL] [M]

Total (4)

Example 2:

$$
\begin{array}{rl}
 & 24 \times 13 = \ldots (1) \\
+) & 56 \div 7 = \ldots (2) \\
-) & 32 \times 4 = \ldots (3) \\
\hline
 & \text{(total)} \quad \ldots (4)
\end{array}
$$

24 [×] 13 [STO] [M]

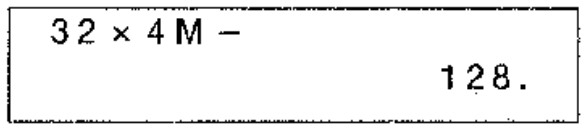


Answer for (1)

56 [÷] 7 [M+]

Answer for (2)

32 [×] 4 [2nd F] [M−]



Answer for (3)

[RCL] [M]

Total (4)

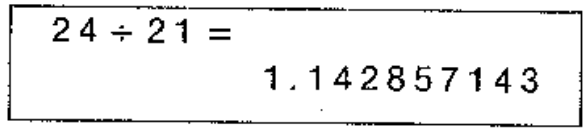
Example 3:

$24 \div \underline{(7 \times 3)} = \ldots$ (1)

$\underline{(7 \times 3)} \times 5 = \ldots$ (2)

7 [×] 3 [STO] [M]

24 [÷] [RCL] [M] [=]



Answer for (1)

[RCL] [M] [×] 5 [=]

Answer for (2)

In the example above, the result of the multiplication 7 × 3 in calculation (1) is first stored in memory and is then recalled as a constant for calculations (1) and (2).

Note:
The equals key need not be pressed before [STO] [M], [M+], and [2nd F] [M−] as these keys also function as the equals key.

Store Memories

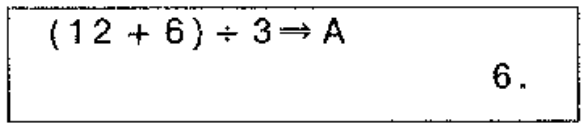
- How to use memories (A to I, M, X, Y, and Z)
  Data movement in and out of each of the 13 store memories is effected by the following two control keys and the 13 memory designation keys [A] to [I], [M], [X], [Y] and [Z].

[STO]: Clears the contents of the designated memory and stores the number in the display, or the result of a calculation, in the memory.
[RCL]: Recalls the contents of the designated memory.

Example:

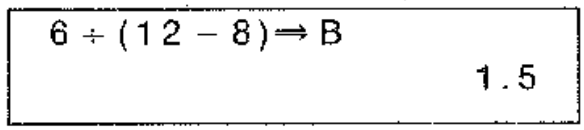
To solve for $C=\frac{AB}{(A+B)}$ with $A=\frac{(12+6)}{3}$ and $B=\frac{6}{(12-8)}$

[(] 12 [+] 6 [)] [÷] 3 [STO] [A]



Answer for (A)

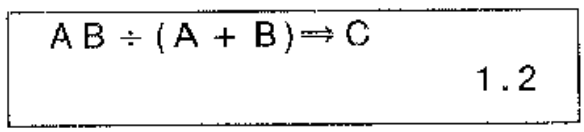
6 [÷] [(] 12 [−] 8 [)] [STO] [B]



Answer for (B)

[ALPHA] [A] [ALPHA] [B] [÷] [(] [ALPHA] [A] [+] [ALPHA] [B]

[)] [STO] [C]



Answer for (C)

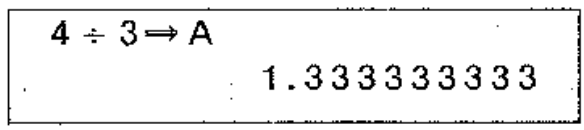
Note:

1. × may be omitted for multiplication between store memories (e.g., AB) or for multiplication when a store memory is a multiplier (e.g., 3 × A, 5 × B).
2. Store memories following the [STO] or [RCL] key can be entered without pressing the [ALPHA] key.

- Use of memories in expression
  With this calculator, the initial capacity of each memory to store the result of a calculation is 10 digits max. for mantissa and 2 digits max. for exponent.
  Any of the memory designation keys may be entered in an expression to use the contents of the designated memory in the expression. Any of the memory designation keys preceded by the [RCL] key may also be used to display the contents of the designated memory and write them into the expression for calculation.

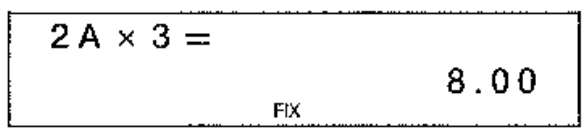
Example 1:
Store the result of 4 ÷ 3 in memory A and then perform the following calculations.

4 [÷] 3 [STO] [A]



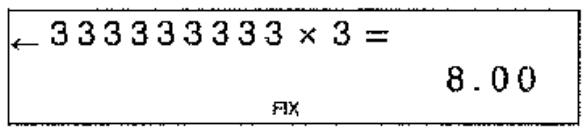
① To use an expression written directly with [A] key.

[FSE] (To display FIX indicator)
[TAB] 2 (To fix the number of places to 2)
2 [ALPHA] [A] [×] 3 [=]



② To use an expression written with [RCL] and [A] keys.

2 [×] [RCL] [A] [×] 3 [=]



In the Example ①, all the contents of memory A (10-digit mantissa and 2-digit exponent) are used, whereas in Example ②, only the internal digits of memory A specified by FIX, TAB=2 are used for calculation.

Notes:

1. Store memory M shares the same memory area as the independently accessible memory.
2. The result of a calculation cannot be automatically added to or subtracted from designated memories. A manual key sequence should be used. For example, to add the calculation result 5 to memory A, the following key sequence is required: 5 [+] [ALPHA] [A] [STO] [A].

Binary, Octal and Hexadecimal Calculations

This calculator can perform conversions between decimal, binary, octal, and hexadecimal numbers. It can also perform the four basic arithmetic operations on numbers expressed in these number modes. Decimal fractions are only possible in the DEC mode.

Number Modes

To perform conversions between decimal, binary, octal, and hexadecimal numbers, the calculator must be set in COMP mode with one of the following number modes.

Note:

Hexadecimal numbers A to F are displayed as shown below.

Upper line: A, B, C, D, E, F

Lower line: A, b, C, d, E, F

Hexadecimal numbers A to F can be entered directly by pressing the ARCHYP A [HYP], SIN⁻¹ B [SIN], COS⁻¹ C [COS], TAN⁻¹ D [TAN], →D.MS E [→DEG] and nPr F [nCr] keys. (The [2nd F] key need not be pressed.)

[2nd F] [→BIN] Binary Number (BIN) Mode

- Displays 10-digit binary numbers.
- Converts the number in the display into its binary equivalent. When these keys are pressed, BIN is displayed in the lower right of the display.
- If an expression is in the display, the calculator converts it to a binary number.

- In this mode, only [0] and [1] keys can be used, the other number keys become inoperative.

[2nd F] [→OCT] Octal Number (OCT) Mode

- Displays 10-digit octal numbers.
- Converts the number in the display into its octal equivalent. When these keys are pressed, **OCT** is displayed in the lower right of the display.
- If an expression is in the display, the calculator converts it to an octal number.
- In this mode, only [0] to [7] keys can be used, the other number keys become inoperative.

[2nd F] [→HEX] Hexadecimal Number (HEX) Mode

- Displays 10-digit hexadecimal numbers.
- Converts the number in the display into its hexadecimal equivalent. When these keys are pressed, **HEX** is displayed in the lower right of the display.
- If an expression is in the display, the calculator converts it to a hexadecimal number.
- In this mode, keys [0] to [9] and hexadecimal number keys [A] to [F] (above [HYP], [SIN], [COS], [TAN], [→DEG], [nCr]) can be used. The decimal point key only becomes inoperative.

[2nd F] [→DEC] Decimal Number (DEC) Mode

- Converts the number in the display into its decimal equivalent. When these keys are pressed, no indicator appears in the display. Since the calculator normally uses this number system, the absence of an indicator means that the unit is in the decimal mode.

- If an expression is in the display, the calculator converts it to a decimal number.
- In this mode, keys [0] to [9] are used to perform the four basic arithmetic operations and scientific calculations.

Reference table for the four number modes

Decimal	Binary	Octal	Hexadecimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14
:	:	:	:

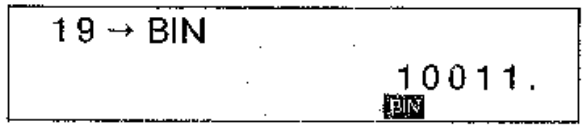
Conversions of Binary, Octal, Decimal, and Hexadecimal Numbers

Before performing the examples below, be sure the FIX, SCI or ENG indicator is not displayed.

Example 1:

Convert decimal number 19 into its binary equivalent (10011 from reference table).

[CL] [2nd F] [→DEC] 19 (Decimal number)
[2nd F] [→BIN] (Dec to Bin)



Example 2:

Convert hexadecimal number 2BC into its decimal equivalent.

[CL] [2nd F] [→HEX] 2 B C (Hexadecimal number)
[2nd F] [→DEC] (Hex to Dec)

Note:

Use the hexadecimal number keys [HYP], [SIN], [COS], [TAN], [→DEG], and [nCr] to enter A, B, C, D, E, and F in the HEX mode.

Example 3:

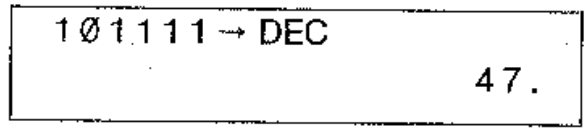
Convert octal number 52 into its hexadecimal equivalent.

2nd F →OCT 52 (Octal number)
2nd F →HEX (Oct to Hex)

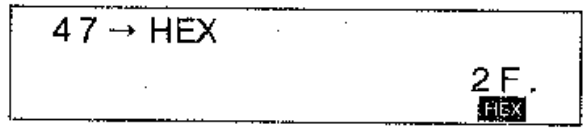
Example 4:

Convert binary number 101111 into its decimal, hexadecimal, and octal equivalents respectively.

2nd F →BIN 101111 (Binary number)
2nd F →DEC (Bin to Dec)



2nd F →HEX (Dec to Hex)

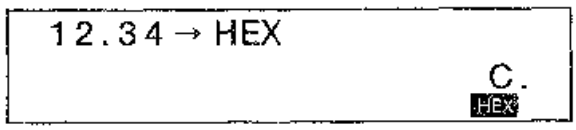


2nd F →OCT (Hex to Oct)

Example 5:

Convert a decimal number with a fraction part into its binary, octal, or hexadecimal equivalent.

[2nd F] [→DEC] 12.34 [2nd F] [→HEX]



As shown in the above example, the fraction part (0.34) is truncated and only the integer part (12) is converted into its hexadecimal equivalent.

Binary, Octal, and Hexadecimal Number Calculations

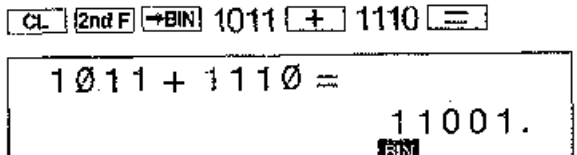
With this calculator, the four basic arithmetic operations (add, subtract, multiply, and divide) and memory calculations can be performed in the BIN, OCT, and HEX modes in the same way as the normal DEC mode. Scientific functions can only be performed in the DEC mode.

- Calculations in BIN mode

Example 1:

1011+1110 =

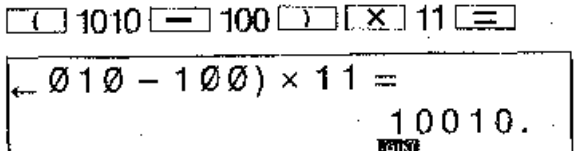
[CL] [2nd F] [→BIN] 1011 [+] 1110 [=]



Example 2:

(1010 − 100) × 11 =

[(] 1010 [−] 100 [)] [×] 11 [=]



• Calculations in OCT Mode

Example 1:

5+7=

[CL] [2nd F] [→OCT] 5 [+] 7 [=]

Example 2:

32÷2=

32 [÷] 2 [=]

• Calculations in HEX mode

Example 1:

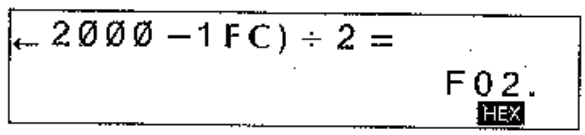
2FF−25=

[CL] [2nd F] [→HEX] 2 F F [−] 25 [=]

Example 2:

(2000−1FC)÷2=

[(] 2000 [−] 1 F C [)] [÷] 2 [=]

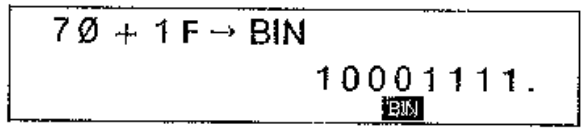


• Mixed calculations

Example 1:

Add decimal number 112 to hexadecimal number 1F and convert the calculation result into a binary number

[CL] [2nd F] [→DEC] 112 [2nd F] [→HEX] [+] 1F [2nd F] [→BIN]



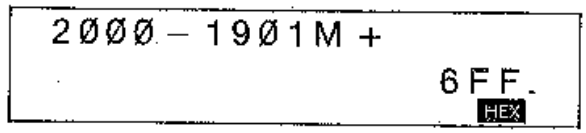
Example 2:

$$\begin{array}{r} 2FEC-2C9E = \ldots(1) \\ +)2000-1901 = \ldots(2) \\ \hline \text{Total (decimal number) (3)} \end{array}$$

[CL] [STO] [M] [2nd F] [→HEX] 2FEC [−] 2C9E [M+]

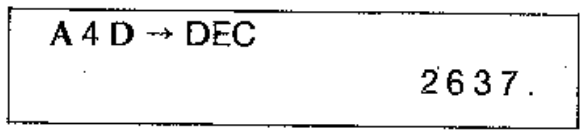
Answer for (1)

2000 [−] 1901 [M+]



Answer for (2)

[RCL] [M] [2nd F] [→DEC]



Answer for (3)

Note:
In binary, octal, or hexadecimal calculations, if the result or intermediate result of a calculation is a number with a fraction part, the result is displayed with its fraction part truncated.

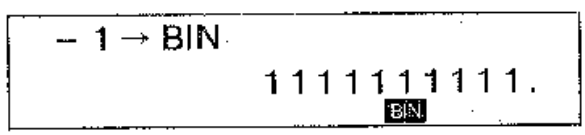
Example:
5÷2=

2nd F →OCT 5 ÷ 2 =

In the BIN, OCT, or HEX mode, a negative number is displayed as a complement corresponding to the designated number system.

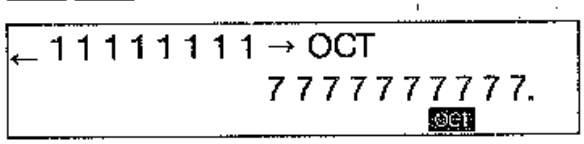
Example:

2nd F →DEC 1 +/− 2nd F →BIN



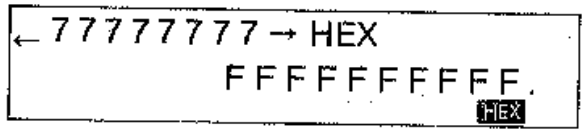
(Two's complement)

2nd F →OCT



(Eight's complement)

2nd F →HEX



(16's complement)

In the BIN, OCT, or HEX mode, a negative number is entered using the NEG key.

Example:

Enter negative hexadecimal number 2.

2nd F →HEX NEG 2 =

Logical Operations

This calculator can perform logical NOT, AND, OR, XOR (exclusive OR), and XNOR (exclusive NOR) operations on binary, octal, and hexadecimal numbers. To enter logical operators, NOT, AND, OR, XOR, and XNOR, use the [Y^x], [LOG], [LN], [x²], and [√‾] keys, respectively.

The truth table of the logical operations is shown below.

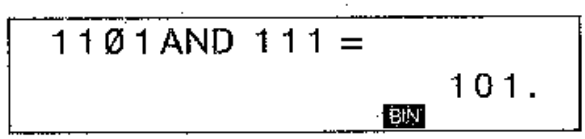
A	B	A AND B	A OR B	A XOR B	A XNOR B
0	0	0	0	0	1
1	0	0	1	1	0
0	1	0	1	1	0
1	1	1	1	0	1

A	NOT A
0	1
1	0

Example 1:

AND binary numbers 1101 and 111

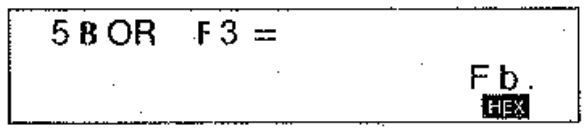
[CL] [2nd F] [→BIN] 1101 [AND] 111 [=]



Example 2:

OR hexadecimal numbers 5 B and F3

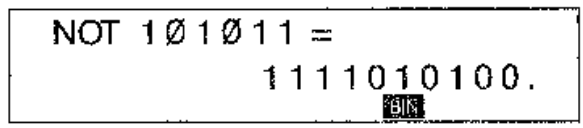
CL 2nd F →HEX 5 B OR F 3 =



Example 3:

NOT binary number 101011

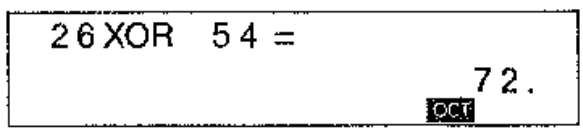
CL 2nd F →BIN NOT 101011 =



Example 4:

Exclusive OR octal numbers 26 and 54

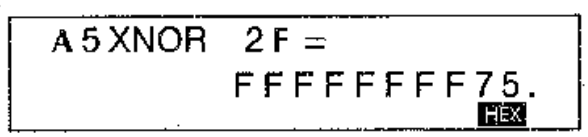
CL 2nd F →OCT 26 XOR 54 =



Example 5:

Exclusive NOR hexadecimal numbers A 5 and 2 F

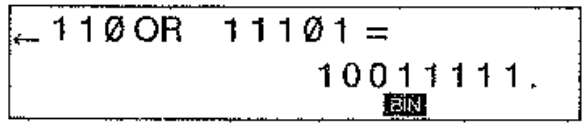
CL 2nd F →HEX A 5 XNOR 2 F =



Example 6:

OR hexadecimal number 8 E and binary number 11101

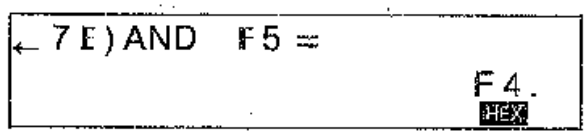
[CL] [2nd F] [→HEX] 8 E [2nd F] [→BIN] [OR] 11101 [=]



Example 7:

AND hexadecimal number F 5 and the result of ORing hexadecimal numbers 84 and 7 E

[CL] [2nd F] [→HEX] [(] 84 [OR] 7 E [)] [AND] F 5 [=]



Statistical Calculations

This calculator can perform single and two variable statistical calculations in the COMP mode. All statistical data that you enter for calculation is stored in the memory and will be retained even when the calculator enters the Auto Power Off state or is turned off by operating the [OFF] key.

- The results of statistical calculations cannot be cleared with the [CL] key. Use the [2nd F] and [CA] keys to clear the statistics stored in memory before you start a statistical calculation.

- Ensure that the calculator is in the DEC mode (BIN, OCT and HEX indicators should not be displayed).

- Even after the results of a statistical calculation have been obtained, additional information can be entered and the statistical calculations can be performed continuously on additional data entry.

Statistics Available

① Single Variable Statistical Calculation

(1) n: Number of samples
(2) Σx : Sum total of samples
(3) Σx^2 : Sum of squares of samples
(4) $\bar{x}$: Mean value of samples

$$\bar{x} = \frac{\Sigma x}{n}$$

(5) sx: Standard deviation with population parameter $n-1$.

$$sx = \sqrt{\frac{\Sigma x^2 - n\bar{x}^2}{n-1}}$$

(Used to estimate the standard deviation of a population from sample data extracted from that population.)

(6) σx : Standard deviation with population parameter n.

$$\sigma x = \sqrt{\frac{\Sigma x^2 - n\bar{x}^2}{n}}$$

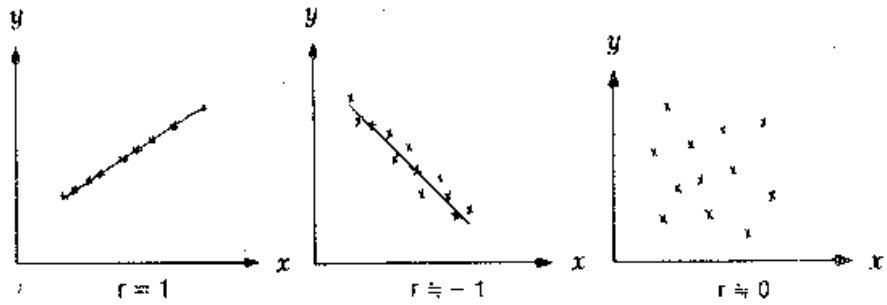
(Used when all the population is taken as sample data or when finding the standard deviation of a population with samples taken from that population.)

② Two Variable Statistical Calculation

Statistics for both x and y, such as n, Σx, $\bar{x}$, Σx^2, sx, σx, and Σy, $\bar{y}$, Σy^2, sy, σy are the same as those for x in single variable statistics, except that samples are identified as x and y, respectively. In addition, Σxy (the sum of the product of samples x and y) is obtained in this calculation.

③ Linear Regression

With Linear Regression, there are three important values: r, a, and b. The correlation coefficient r shows the quantitative relationship between two variables x and y for a particular sample. The value of r is between -1 and 1. If r equals -1 or 1, all points on the correlation diagram are on a line. The further the value of r is from -1 or 1, the less the points are collected about the line. The closer the value of r to 0, the less reliable is the correlation. If r is more than 0, it shows a positive correlation (y is proportional to x) and if r is less than 0, it has a negative correlation (y is inversely proportional to x).



The equation for the straight line is $y=a+bx$. The point at which the line crosses the y axis is a. The slope is b.

r: Correlation coefficient

$$r = \frac{Sxy}{\sqrt{Sxx \cdot Syy}}$$

a, b: Coefficients of the linear regression equation

$y=a+bx$

$a=\bar{y}-b\,\bar{x}$

$$b=\frac{Sxy}{Sxx}$$

x': Estimated value (the value of x estimated from y.)

$$x' = \frac{y-a}{b}$$

y': Estimated value (the value of y estimated from x.)
$y' = a + bx$

$$Sxx = \Sigma x^2 - \frac{(\Sigma x)^2}{n}$$

$$Syy = \Sigma y^2 - \frac{(\Sigma y)^2}{n}$$

$$Sxy = \Sigma xy - \frac{\Sigma x \cdot \Sigma y}{n}$$

- Data Input Formats

① When inputting single data
- Single-variable data: Data [DATA]
- Two-variable data: Data (x) [x,y] data (y) [DATA]

② When inputting multiple data
- Single-variable data: Data [×] frequency [DATA]
- Two-variable data: Data (x) [x,y] data (y) [×] frequency [DATA]

Note:
In formats with data in the form of an expression, the expression must be parenthesized when +, −, ×, or ÷ is used in the expression.

For example;
(5+4×3) [DATA] (Frequency of data is 1.)
(SIN3+LN2)×5 [DATA] (Frequency of data is 5.)

If the expression was not parenthesized, 5+ and SIN3+ would be ignored, and the same results would be returned as for key operations 4×3 and LN2×5 [DATA].

Single Variable Statistical Calculation Example

Obtain the mean value and standard deviation of the examination marks of the 35 randomly selected students shown in the table below.

Data No.	Marks in exam	No. of students	Data No.	Marks in exam	No. of students
1	30	1	5	70	8
2	40	1	6	80	9
3	50	4	7	90	5
4	60	5	8	100	2

Data entry
Enter the data from the table according to the data input format for single variable data: Data [X] Frequency [DATA].

[2nd F] [CA] (To clear all statistics value in memories)
30 [DATA] 40 [DATA]

```
4Ø DATA
                    2.
```

(Number of samples is displayed)

50 [X] 4 [DATA] 60 [X] 5 [DATA]

```
6Ø × 5 DATA
                   11.
```

70 [X] 8 [DATA] 80 [X] 9 [DATA]

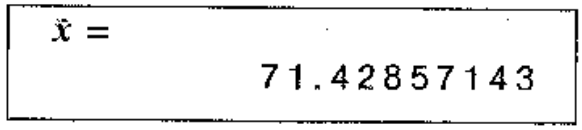
```
8Ø × 9 DATA
                   28.
```

90 [X] 5 [DATA] 100 [X] 2 [DATA]

```
1ØØ × 2 DATA
                   35.
```

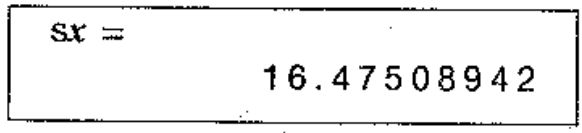
- Mean value

RCL $\bar{x}$

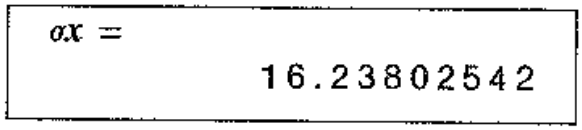


- Standard deviation

RCL s_x



RCL σ_x

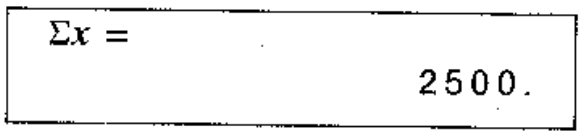


- Number of samples

RCL n

- Sum total of samples

RCL Σx



• Sum of squares of samples

RCL Σx^2

Σx^2 =
187800.

Notes:

1. After all the data have been entered, statistics such as mean value, standard deviation, etc., may be obtained in any desired order.
2. After mean value, standard deviation, or any other statistic has been obtained as an intermediate result, more data can be entered in any sequence and statistical calculations can be performed continuously on the additional data.
3. The DATA key may be pressed consecutively to enter two or more of the same data instead of key operation; X frequency DATA.

Data entry correction

If incorrect data has been entered, the incorrect entry can be corrected by pressing the 2nd F CD keys.

Example:

Correct the marks of data No. 3 incorrectly entered as 55 instead of 50 in the above example.

55 X 4 DATA

55 × 4 DATA
6.

(Incorrect data is input)

- Data correction

55 [×] 4 [2nd F] [CD]

```
55 × 4 CD
                                2.
```

(Incorrect data is cleared)

50 [×] 4 [DATA]

```
50 × 4 DATA
                                6.
```

(Correct data is input)

Two Variable Statistical Calculation Example

The table below shows the date (in April) when the cherry blossoms bloom and the average temperatures for March at that location. Obtain coefficients a and b for the linear regression line $y = a + bx$ and the correlation coefficient (r). Also estimate the date when the cherry blossoms will bloom when the average temperature for March is 9.1 degrees, and the average temperature for March when the cherry blossoms bloom on April 10.

Linear regression calculation

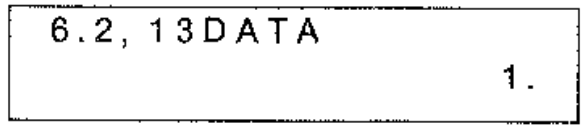
Year	2	3	4	5	6	7	8	9
Average temperature (x degrees)	6.2	7.0	6.8	8.7	7.9	6.5	6.1	8.2
Bloom date (y date)	13	9	11	5	7	12	15	7

Operation

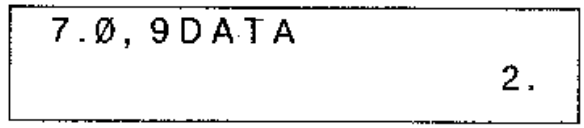
Enter the data given in the table using the method for entering two-variable data.

[2nd F] [CA] 6.2 [(x, y)] 13

[DATA]

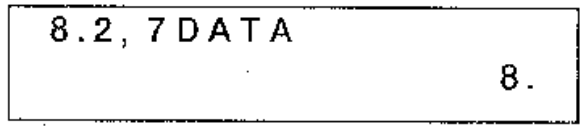


7.0 [(x, y)] 9 [DATA]

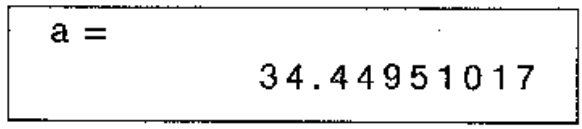


⋮

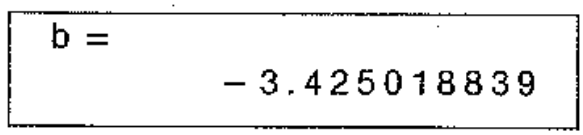
8.2 [(x, y)] 7 [DATA]



[RCL] [a]



[RCL] [b]



RCL r

```
r =
          -0.969106837
```

9.1 2nd F ŷ (To estimate the date of bloom)

```
9.1Y'
          3.281838734
```

(Estimated date of bloom is April 3)

10 2nd F x̂ (To estimate the average temperature)

```
10X'
          7.13850385
```

(Estimated average temperature of March is approximately 7.1°C.)

Data entry correction

Correct the entered data in the same manner as described for single variable statistical calculations.

All statistical data clear

To clear all the entered data and statistics, press 2nd F CA in the COMP mode (must be in the DEC mode).

Chapter 3
AER Mode

The Algebraic Expression Reserve (AER) mode is convenient for repetitive calculations. This mode allows you to program calculation procedures (i.e., algebraic expressions) into the calculator in the AER mode so that the calculator may automatically execute calculations on numbers (variables) which you enter in the COMP mode. The calculator has a programming capacity of 256 steps (or 256 bytes) for storing programs consisting mainly of algebraic expressions and mathematical formulas. In addition, the calculator can perform conditional expression decisions and looping.

How to Use the AER Mode

The AER mode is selected or cleared with the [2nd F] [AER] keys.

- In addition to mathematical formulas, statistical magnitudes or data can also be stored in algebraic expressions, so that you can compute statistics (such as exponential or logarithmic regression) with simple operations.

Memory Organization

The algebraic expression store memory space can be divided into up to four areas. Any one of the four areas can store up to 160 steps of programmed expressions, (the entire algebraic expression storage capacity is 256 steps). When the AER mode is selected, the calculator displays the area where an expression was last executed or stored.

- To select one of the four algebric expression storage areas, operate keys [2nd F] [1:] through [2nd F] [4:] in the AER mode. If you attempt these key operations in COMP mode, the calculator selects the corresponding area and then immediately executes the algebric expression stored in that area.

[2nd F] [AER]

[2nd F] [1:]

└ Algebraic expression storage area number

Some Basics on AER Operations

Before programming an algebraic expression in AER mode, press the Reset switch on the back of the calculator to clear all the memory contents.

ALL CL? → ENT

When you see this prompt on the display, press the [ENT] key (see page 106.)

Input Format

You can use memories A to I, M, X, Y, and Z in expressions with the form: "f( )= expression." Any memories specified in the parentheses of "f( )=" are treated as variables.

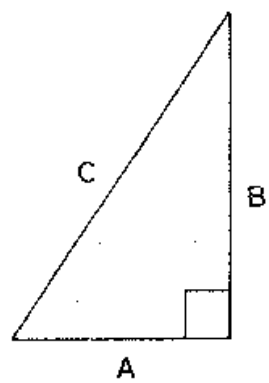
Example 1: Pythagorean theorem

In this example, we will determine the length of side C, of a right-angled triangle, from given lengths of the other sides A and B. The formula we use for the solution is:

$C = \sqrt{A^2 + B^2}$ (side C is opposite to the right angle).

For calculation on the computer, we use the following algebraic expression:

$f(AB) = \sqrt{\ }(A^2 + B^2)$

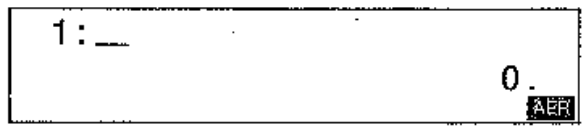


First select the AER mode with [2nd F] [AER], then program the expression above.

Program List:
1: f(AB)= $\sqrt{\ }(A^2+B^2)$

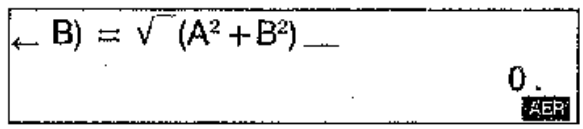
Programming:

[2nd F] [AER]



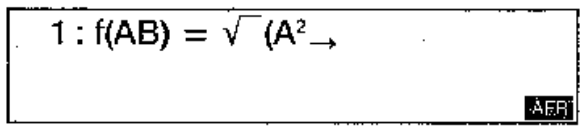
(AER mode)

[f( )=] [ALPHA] [A] [ALPHA] [B] [f( )=] [√‾] [(] [ALPHA] [A] [x^2] [+]
[ALPHA] [B] [x^2] [)]



(Algebraic expression input)

[ENT]

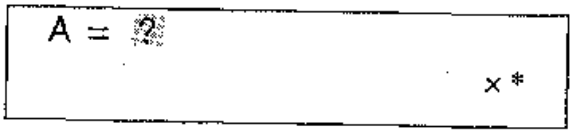


(Programming completed)

Now let's execute the programmed expression by giving specific values to variables A and B:
example: A = 3, B = 4
To execute the algebraic expression you have programmed, press the [ENT] key again, the calculator returns to COMP mode and executes the expression. Instead of pressing the [ENT] key again, you may also execute the expression by returning to the COMP mode (with [2nd F] [AER]), then choosing the algebraic expression storage area where the expression has been programmed (with [2nd F] [1:] to [2nd F] [4:]).

Procedure (direct execution):

ENT



↳ Cursor blinks

3 COMP

↳ Cursor blinks

4 COMP

*If any data is already entered, the calculator displays that data. This is the same for the displays on page 89 and subsequent pages.

When you have assigned values to all variables, the calculator displays the result of computation.

When you assign more than one expression to a single algebriac expression, separate them with spaces (␣) or commas (,). If commas are used as delimiters, the calculator displays the result of the expression which precedes each comma. If spaces (␣) are used as delimiters, the calculator executes the expression that follows each space, without displaying the result of the expression which precedes each space.

• **Programming without using f( )=:**

Example:

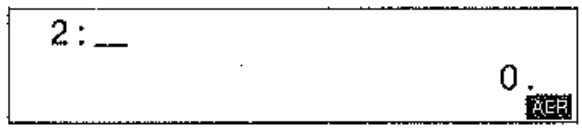
To substitute the expression, f( )=$3A^2+7A+9$, for incremental values of variable, A = 1, 2, 3, ..., and determine the result for each value (plot computation).

Program list:

2: $A+1 \Rightarrow A, 3A^2+7A+9$

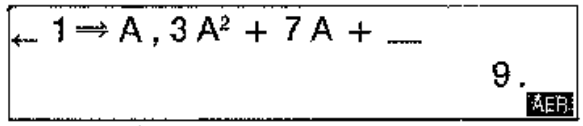
Programming:

[2nd F] [AER] [2nd F] [2:]

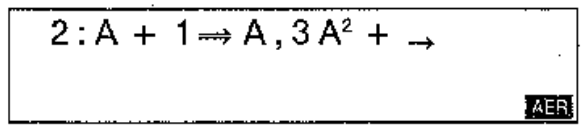


(Specifies algebraic expression area)

[ALPHA] [A] [+] 1 [STO] [A] [2nd F] [•] 3 [ALPHA] [A] [x^2] [+] 7 [ALPHA] [A] [+] 9



[ENT]



Procedure:

[2nd F] [AER]

(COMP mode)

[CL] [STO] [A]

```
Ø ⟹ A
                    0.
```

[2nd F] [2:]

```
ANS 1 =
                    1.
```

(Value of variable A)

[COMP]

```
ANS 2 =
                   19.
```

(Answer for A=1)

[COMP]

```
ANS 1 =
                    2.
```

(Value of variable A)

[COMP]

```
ANS  2 =
                   35.
```

(Answer for A=2)

As you see in the example above, you do not need to specify variables with the [f()=] key if you program an expression that computes the values of the variable instead of assigning values to the variable.

Note:
After a programmed algebraic expression has been executed, the calculator holds the values of the variables used in that expression until other values are assigned to them. Values already assigned to variables are displayed on the lower line of the display when the expression is executed so that you can verify them as follows.

2nd F AER (Selects the COMP mode)

(COMP mode)

2nd F 1:

↳ Cursor blinks.

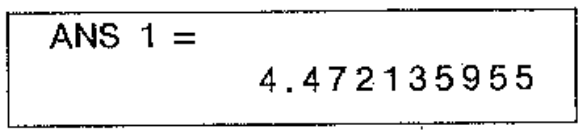
(Displays the value stored as variable A)

COMP

↳ Cursor blinks.

(Displays the value stored as variable B)

COMP



Example 2: Exponential regression calculation

The equation for the linear regression line, $y = a + bx$, is used in exponential regression calculations.

Take natural logarithm of both sides of equation, $y = a e^{bx}$:

$\ln y = \ln a + bx$ ..... (1)

Substituting Y for $\ln y$ and A for $\ln a$ gives:

$Y = A + bx$ ..... (2)

where $a = e^{A}$ and $y = e^{Y}$.

Program list:

1: f(XY)=LN Y⇒Y␣X, YDATA

Enter using the [DATA] key.

Enter using the [(x,y)] key.

2: e^{x}a

Enter using the [ALPHA] and [a] keys.

3: f(X)=Xy' ␣ e^{x}ANS

Enter using the [ALPHA] and [ANS] keys.

Enter using the [2nd F] and [y'] keys.

Variable descriptions:

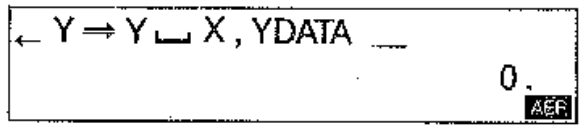
Variable	Description	Remarks
X	Data for x	
Y	Data for y	
1: ANS 1	Number of data items	
2: ANS 1	Coefficient a	e^{x} A
3: ANS 1	Estimated value y'	e^{x} Y

Programming:

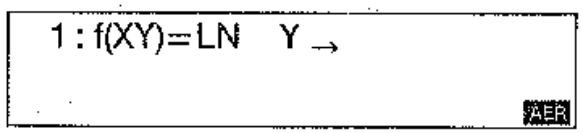
2nd F AER
2nd F 1:
2nd F CA ENT

(To delete an expression, designate its algebraic expression storage area and then press 2nd F CA ENT. Refer to page 106.)

f( )= ALPHA x ALPHA Y f( )= LN ALPHA Y STO Y 2nd F
↵ ALPHA x (x, y) ALPHA Y DATA



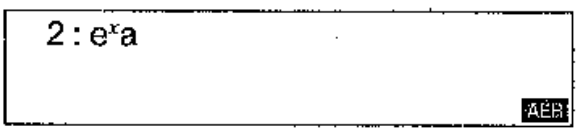
ENT



2nd F 2: 2nd F CA ENT

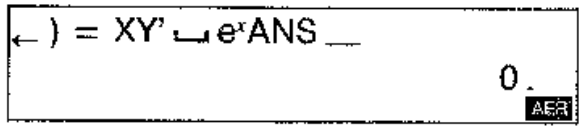
2nd F e^x ALPHA a

ENT

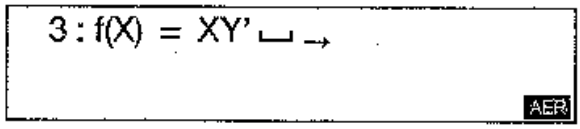


2nd F 3:

f( )= ALPHA x f( )= ALPHA x 2nd F y' 2nd F ␣ 2nd F e^x
ALPHA ANS



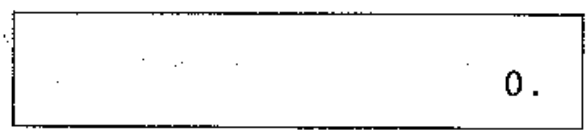
ENT



From the data below, determine coefficients, a and b, of $y = a \cdot e^{bx}$, and correlation coefficient, r, and estimate the value of y when $x = 12$.

No.	1	2	3	4	5	6
x	2.0	7.0	9.2	4.3	5.1	8.0
y	0.6	4.2	8.3	1.2	2.7	5.1

2nd F AER



(COMP mode)

2nd F CA (Clears all statistics data)

2nd F 1:

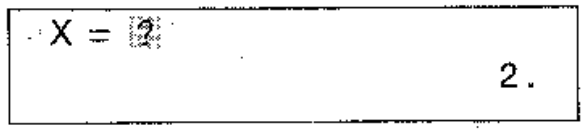
↳ Cursor blinks.

2 COMP

↳ Cursor blinks.

0.6 COMP

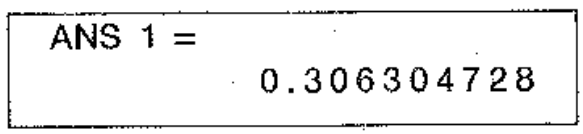
COMP



↳ Cursor blinks.

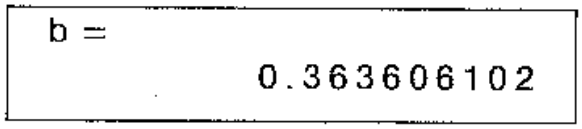
7.0 COMP 4.2 COMP COMP 9.2 COMP 8.3 COMP COMP 4.3 COMP
1.2 COMP COMP 5.1 COMP 2.7 COMP COMP 8.0 COMP 5.1 COMP

2nd F 2:



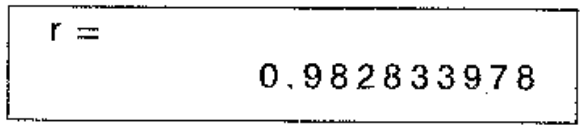
(Determines the value of coefficient *a*.)

RCL b



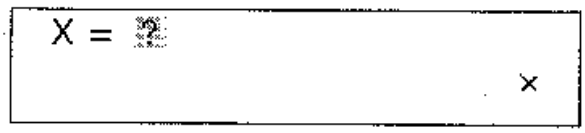
(Determines the value of coefficient *b*)

RCL r



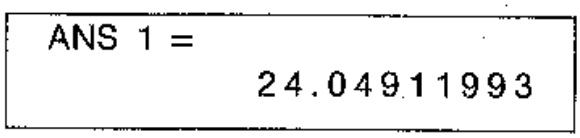
(Determines the value of correlation coefficient *r*)

2nd F 3:



↳ Cursor blinks.

12 COMP (Determines the value of *y* when *x* is 12)



(Estimation: *y* is approximately 24.05)

Conditional Expression Function

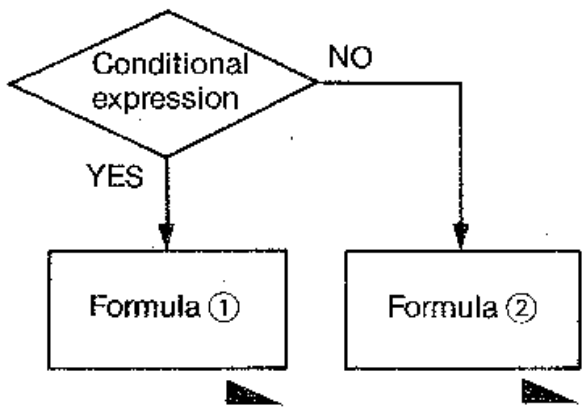
This calculator compares the left side of a conditional expression (in which the >, >=, or ≠ sign is used) with its right side, and based on the result of the comparison determines the destination of the next calculation to be executed. If the condition in the expression is true, the calculator executes the YES calculation or operation (enclosed by brackets preceded by ➡Y➡). If it is false, the calculator executes the NO calculation or operation (enclosed by brackets preceded by ➡N➡).

Note:
A conditional expression cannot be used inside the ➡Y➡ [ ] or ➡N➡ [ ] brackets.

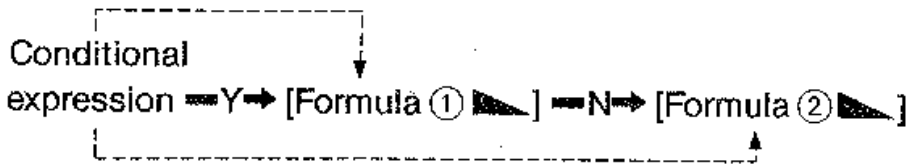
You can write a conditional expression with the following forms:

Left side > Right side	Is the left side greater than the right side?
Left side ≠ Right side	Is the left side not equal to the right side?
Left side >= Right side	Is the left side greater than or equal to the right side?

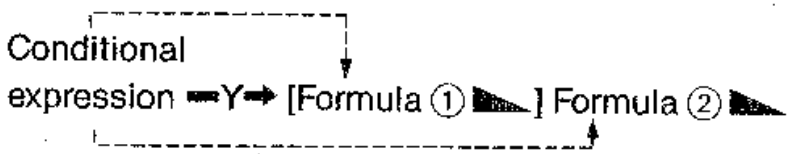
Flowchart of Conditional Expression Function (example 1)



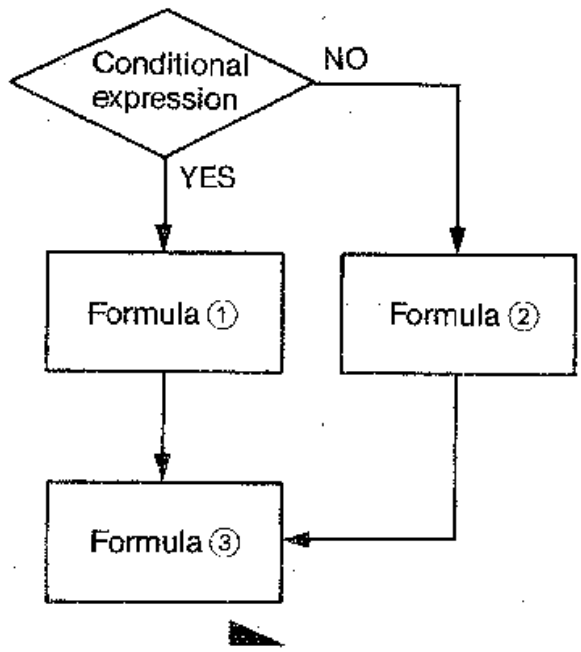
In the conditional expression as shown in the flowchart, if a given condition is true (YES), formula ① is executed. If a given condition is false (NO), formula ② is executed. This decision is made using the [-Y→[]] and [-N→[]] keys as shown below:



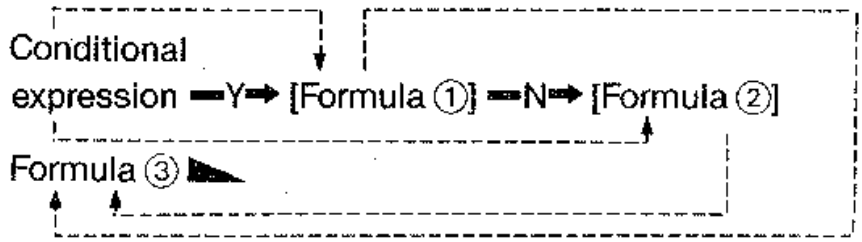
Note:
Either of -Y→ [ ] or -N→ [ ] may be omitted from entry as shown below.



Flowchart of Conditional Expression Function (example 2)



In the conditional expression shown in the previous flowchart: If YES, formula ③ is executed after formula ①. If NO, formula ③ is executed after formula ②.



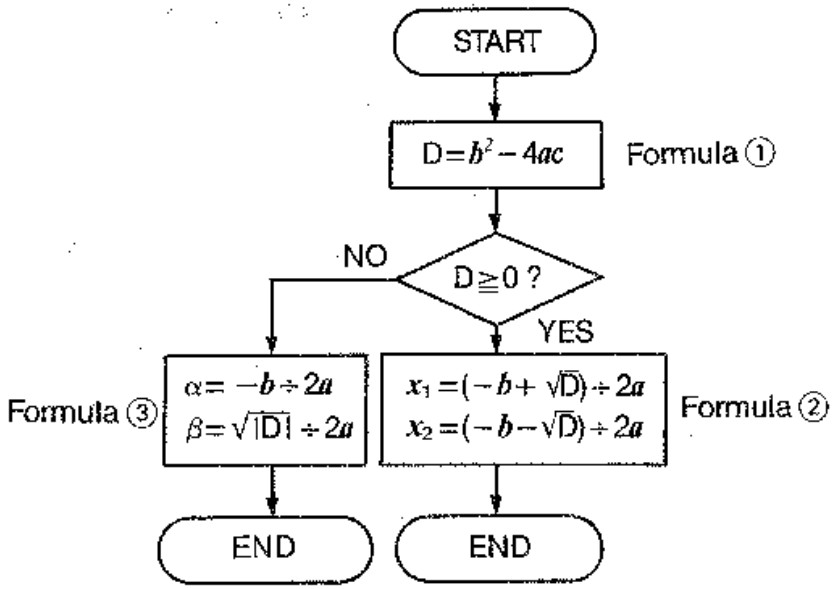
- To terminate a series of calculations, the [2nd F] [▬] (calculation end command) keys must be entered after the last formula in the series.

Example: Quadratic equation
Solve $ax^2+bx+c=0$, where $a \neq 0$ and a, b, and c are real numbers.
The quadratic equation can be solved by the following formula:

$$x=\frac{-b\pm\sqrt{(b^2-4ac)}}{2a}$$

With the value of the discriminant $D=b^2-4ac$, real numbers are solved if $D \geqq 0$, and conjugate imaginary numbers are solved if $D<0$.

• Flowchart of the expression



Formula ① is the discriminant.
The conditional expression determines if the value of the discriminant is equal to or greater than 0.
Formula ② solves for real numbers (x_1, x_2).
Formula ③ solves for imaginary numbers (where α is the real part and β is the imaginary part).

• Input format of the expression
Formula ① Conditional expression
➡Y➡ [Formula ② ◣] ➡N➡ [Formula ③ ◣]

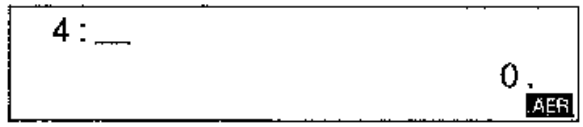
Program list:

```
4: f(ABC)=B²−4AC⇒D⌴D>=0➡Y➡[(−B+√ D)÷2A,
(−B−√ D)÷2A◣]➡N➡[−B÷2A,√ ABS D÷2A◣]
```

Programming:

Key operation

2nd F AER 2nd F 4 :



f( )= ALPHA A ALPHA B ALPHA C f( )= ALPHA B x^2 —

4 ALPHA A ALPHA C STO D 2nd F ⟵ ALPHA D 2nd F

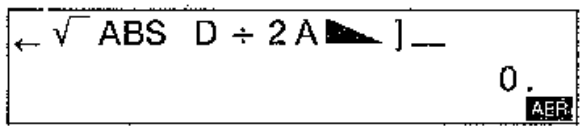
>= 0 2nd F ⇒Y⇒[ ] (+/− ALPHA B + √ ALPHA D

) ÷ 2 ALPHA A 2nd F , (+/− ALPHA B —

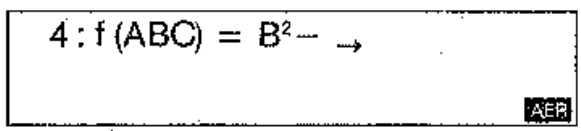
√ ALPHA D) ÷ 2 ALPHA A 2nd F ◣ 2nd F ⇒Y⇒[ ]

2nd F ⇒N⇒[ ] +/− ALPHA B ÷ 2 ALPHA A 2nd F , √

2nd F ABS ALPHA D ÷ 2 ALPHA A 2nd F ◣ 2nd F ⇒N⇒[ ]



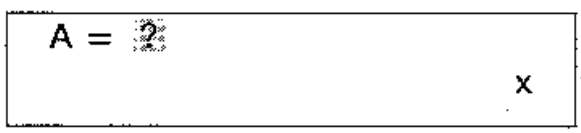
ENT



Procedure:
Let's execute the algebraic expressions you have just programmed by assigning values 2, −4, and 1 to variables A, B, and C, respectively:

Key operation

ENT

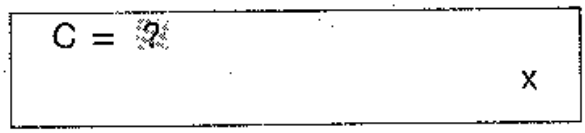


↳ Cursor blinks.

2 COMP

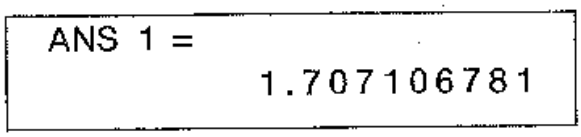
↳ Cursor blinks.

4 +/− COMP



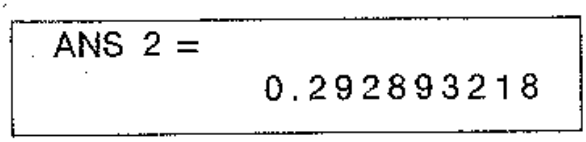
↳ Cursor blinks.

1 COMP



(Solution: x_1(real number))

COMP



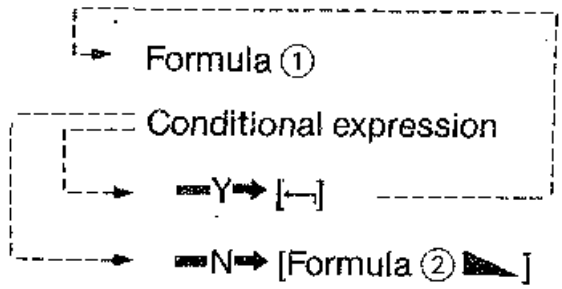
(Solution: x_2(real number))

- In this example, the formula in the brackets [ ] that follows ➡Y➡ was performed as a result of D (discriminant) ≧ 0.

Looping Function

The looping function permits the same calculation or processing to be repeated over and over again. This function is designated in a series of calculation procedures by using two commands: " ↳ " (Return here) and " ↰ " (Return from here to the ↳ command).

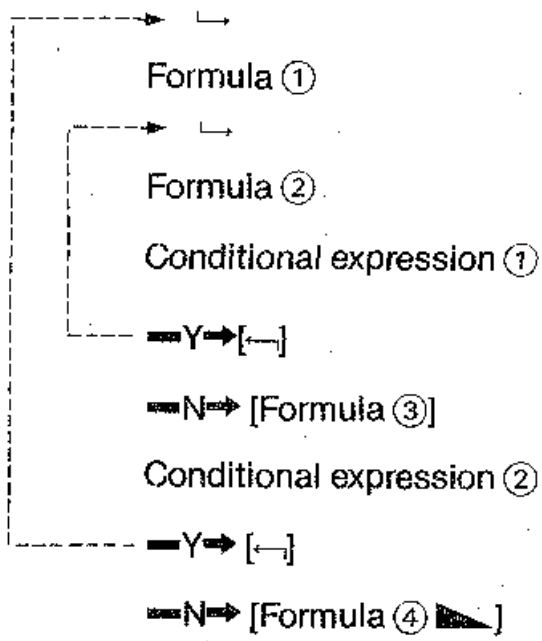
- Basic looping format



If YES, execution returns to formula ①, if NO, formula ② is executed.

Note:
Up to 15 loops can be nested.

- Double-looped conditional expressions



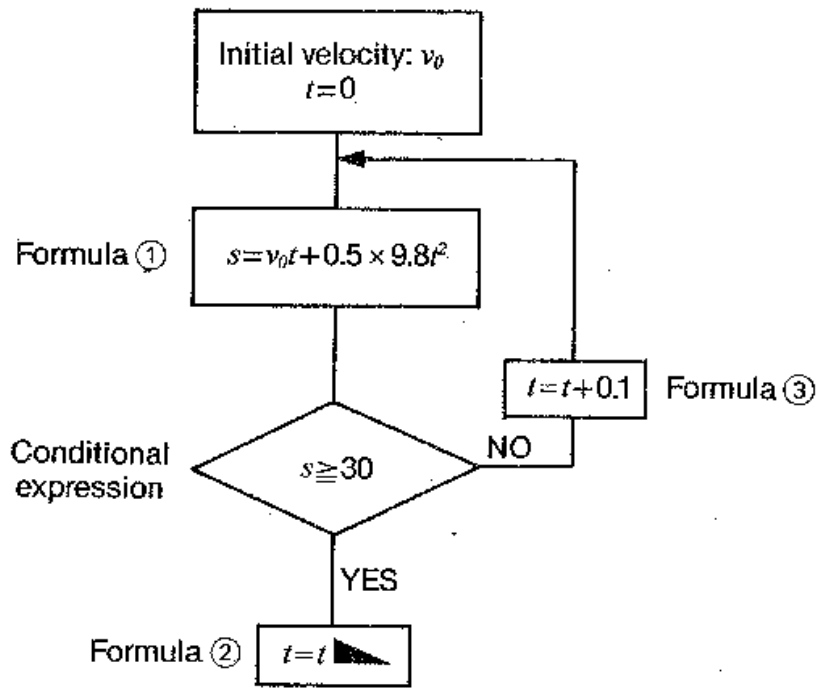
Example: Fall

A program using both the conditional expression and looping functions.

Find the approximate time when a ball falling from a point 30 meters above the ground at an initial velocity of v_0 (m/s) reaches the ground.

Falling distance $s=v_0t+0.5\times9.8t^2$

● Flowchart of expression



● Input format of expression

Formula ①conditional expression ═Y═► [Formula ② ◣]

═N═► [Formula ③ ←┐]

Programming:

Variable descriptions:

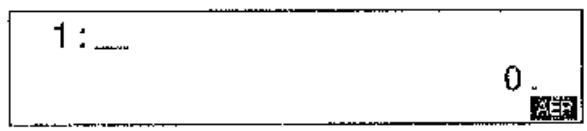
Variable	Description	Unit
A	Initial velocity (v_0)	m/s
ANS 1 (B)	Time (t)	sec.
C	Falling distance (s)	m

Program list:

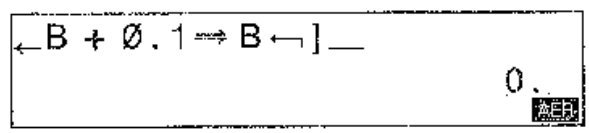
1:0 ⇒ B ⌴ f(A)= ⌴ AB+0.5 × 9.8B² ⇒ C ⌴ C >=
30 ➡Y➡[B ◣]➡N➡[B+0.1 ⇒ B ↩]

Key operation

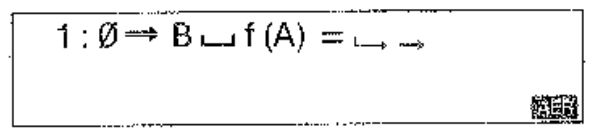
2nd F | AER | 2nd F | 1: | 2nd F | CA | ENT



0 | STO | B | 2nd F | ⌴ | f( )= | ALPHA | A | f( )= | 2nd F
| ⌴ | ALPHA | A | ALPHA | B | + | 0.5 | × | 9.8 | ALPHA | B | x^2
| STO | C | 2nd F | ⌴ | ALPHA | C | 2nd F | >= | 30 | 2nd F | ➡Y➡[ ] | ALPHA
| B | 2nd F | ◣ | 2nd F | ➡Y➡[ ] | 2nd F | ➡N➡[ ] | ALPHA | B | + | 0.1 | STO
| B | 2nd F | ↩ | 2nd F | ➡N➡[ ]



ENT



Procedure:
Let's execute the program by assigning a value 3 to variable A :

ENT

↳ Cursor blinks.

3 COMP

(Approx. 2.2 secs.)

Correcting Stored Contents

To correct the stored contents of an algebraic expression, first display the expression you want to correct by specifying (in AER mode) the area where the expression is stored (2nd F 1: to 4:). Then use the ◄ or ► key to position the cursor at the location where you wish to make a correction, and overtype the correct character.

- DEL deletes the character from the current cursor position.
- INS shifts the character at the cursor position (and all the following characters) to the right, and displays an insert mark (⌐) at the vacated character location. Be sure to press the ENT key after you have finished the necessary correction.

Deleting or Clearing Program Contents

- To delete a specific program from memory, display the program you wish to delete and press the [2nd F] and [CA] keys in AER mode. The following message will appear on the display.
  x: CL? →ENT
  Press the [ENT] key and the program will be deleted from memory. Memory contents can be retained by pressing the [CL] key.

- To clear all the contents stored in the memory, press the reset switch on the back of the calculator, and thefollowing message will appear on the display.

  ALL CL? →ENT
  Press the [ENT] key and all the contents stored in the AER and COMP modes will be cleared from memory. Memory contents will not be cleared if any key other than the [ENT] key is pressed.

Appendixes

Appendix A
Key Functions

[ON] Power ON Key
Used to turn on the calculator.

[OFF] Power OFF Key
Used to turn off the calculator.

[2nd F] 2nd Function Key
Used to designate the second function of another key. The second function is printed in yellow above the key top on the keyboard.
Note:
If this key is pressed by mistake, press the key again to cancel the second function designation.

[ALPHA] Alphabetic Character (Memory) Designation Key
Press to designate the memories (A to I, M, X, Y, Z, and ANS) and statistics.

[CL] Clear Key

Used to release the calculator from an error condition.

COMP mode:

Used to clear numeric data or calculation commands from the display. The memory contents, statistical data, or programs will remain unchanged even after the clear operation.

AER mode:

Used to move the cursor to the beginning of the current line.

[2nd F] [CA] Clear All Key

COMP mode:

Used to clear the statistics. Also used to clear numeric data or calculation commands. The memory contents or programs will remain unchanged even after the clear operation. (The contents of all designated memories will remain unchanged.)

AER mode:

If this key is pressed when an algebraic expression is in the display, a prompt message "×: CL? → ENT" appears to allow you to clear the algebraic expression. To clear the expression press the [ENT] key. If not, press the [CL] key.

[FSE] Display Mode Designation Key

COMP mode:

Used to select the display mode from FIX, SCI, ENG and floating point.

2nd F DRG Degrees/Radians/Grads Selection Key
Used to designate the angle unit (DEG, RAD, or GRAD) for calculation of trigonometric and inverse trigonometric functions and for conversion of coordinates. Each time these keys are pressed the angle unit is changed.
Example: DEG →GRAD
Press the 2nd F DRG keys twice.
"DEG" -
Entries and answers are in degrees (decimal).
"RAD" -
Entries and answers are in radians.
"GRAD" -
Entries and answers are in gradients.

$$90[°] = \frac{\pi}{2}[\text{RAD}] = 100\,[\text{g}]$$

COMP Compute Key
COMP mode:
Used to execute a stored program (algebraic expression).

DEL Delete Key
Used to delete the character (number or letter) at the cursor position. (The cursor does not move.)
Also used to clear the data displayed on the lower line of the display during data entry.

INS Insert key
Provides a blank space for necessary insertion of a character (number or letter) at the cursor position. Pressing this key creates a space at the cursor by moving characters to the right. The insert mark "␣" appears.

[◄] Cursor Left Key

Used to move the cursor left one place. While this key is held down, the cursor moves left rapidly.

Also used as a playback function to move the cursor to the end of the upper line of the display after calculation.

When an error occurs, the cursor moves to the location at the error.

[►] Cursor Right Key

Used to move the cursor right one place. While this key is held down, the cursor moves right rapidly.

This key can be used to shift the numeric data you are inputting in the lower line of the display to the right. Also used as a playback function to move the cursor to the beginning of the upper line of the display after calculation.

When an error occurs, the cursor moves to the location at the error.

[Exp] Exponent Key

Used to enter the exponent part of a number.

Example: 1.234×10^{15}

Key in: 1.234 [Exp] 15

Note:

There are 2 digits for the exponent part. A number with a decimal fraction may be entered, but the calculator ignores the decimal part in the calculation process. If more than two digits are entered, only the last two digits are effective as the exponent.

Example: COMP mode

Key in: 2 [Exp] 1234→"$2.^{34}$" is displayed.

[TAB] Tabulation Key
COMP mode:
Used to fix the number of decimal positions in a calculation result. The number of digits (0 to 9) must be entered following this key.

[2nd F] [ANS] Recall Answer Memory Key
([RCL] [ANS]) Used to recall the data stored in the answer memory.

[2nd F] [M.CK] Memory Check Key
The remaining capacity of the memory is indicated in bytes on the display while the [M.CK] key is held.

[2nd F] [MDF] Modify Key
COMP mode:
Press for the notation of the calculation result now on the display in the next calculation.

[+] Plus Key
Press for addition.

[−] Minus Key
Press for subtraction.

[×] Multiplication Key
Press for multiplication.

[÷] Division Key
Press for division.

[=] Equals Key
Used to obtain the result of a calculation.

[0] to [9] Numeral Keys
Used to enter numerical data.
Example: 1234 →[1] [2] [3] [4]

[(] Open Parenthesis Key
Used to open a parenthesis.

[)] Close Parenthesis Key
Used to close a parenthesis.

[+/−] Change Sign Key
Used to enter a negative number.
Example: −2.4 →[2] [•] [4] [+/−]

[•] Decimal Point Key
Used to place the decimal point in the number entered.
Example: 12.3 →[1] [2] [•] [3]

[STO] Store Key
Used to store a number in any of the 13 memories A to I, M, X, Y, and Z by pressing this key followed by one of [A] to [I], [M], [X], [Y] and [Z] keys.
When these keys (for example, [STO] [A]) are pressed after a number is entered (or a calculation result), the number is stored in memory, replacing the contents previously stored in that memory.

[RCL] Recall Key
Used to recall the contents of the designated memory. To recall any of the 13 memories A to I, M, X, Y and Z, press the [RCL] key and then one of the designated keys (Example: [RCL] [B]). This key is also used to recall statistics.

[A] to [I], [M], [x], [Y], [Z] Memory Designation Keys
When either the [STO] or [RCL] key is pressed followed by one of these keys, the corresponding memory is designated.

[M+] Memory Plus Key
Used to add a calculation result to the contents of the independently accessible memory.

[2nd F] [M−] Memory Minus Key
Used to subtract a calculation result from the contents of the independently accessible memory.

[→DEG] D.MS to Decimal Degrees Conversion Key
Used to convert an angle from the sexagesimal notation system (degrees, minutes, seconds) into a decimal equivalent (in degrees).

[2nd F] [→D.MS] Decimal Degrees to D.MS Conversion Key
Used to convert an angle from the decimal notation system (in degrees) into sexagesimal equivalent (in degrees, minutes, seconds).

[2nd F] [DRG▶] Angular Unit Conversion Key
Press to convert the displayed value into another angle unit (DEG, RAD, GRAD).

[2nd F] [FRAC] Fraction Key
Used to determine and display the fraction part of a number.

[2nd F] [INT] Integer Key
Used to determine and display the integer part of a number.

[2nd F] [ABS] Absolute Value Key
Used to determine and display the absolute value of a number.

[π] Pi Key
Used to enter the constant π ($\pi \doteqdot 3.141592654$).

[Y^x] Power Key
Used to raise a number to the Xth power.

[2nd F] [$\sqrt[x]{\ }$] Power Root Key
Used to obtain the Xth root of a number.

[x^2] Square Key
Used for squaring.

[$\sqrt{\ }$] Square Root Key
Used for square root calculations.

[2nd F] [$\sqrt[3]{\ }$] Cubic Root Key
Used for cubic root calculations.

[2nd F] [10^x] Common Antilogarithm Key
Used to obtain the antilogarithm to the base 10.

[LN] Natural Logarithm Key
Used to obtain the logarithm to the base e ($e \doteqdot 2.718281828$).

[2nd F] [e^x] Exponential Function Key
Used to obtain the exponential (antilogarithm to the base e) of the displayed number.

[LOG] Common Logarithm Key
Used to obtain the logarithm to the base 10.

[2nd F] [x^{-1}] Reciprocal Key
Used for reciprocal calculations.

[HYP] Hyperbolic Function Key
Used with the respective trigonometric function keys to calculate hyperbolic functions (SINH, COSH, TANH).

[2nd F] [ARC HYP] Inverse Hyperbolic Function Key
Used with the respective trigonometric function keys to calculate inverse hyperbolic functions ($SINH^{-1}$, $COSH^{-1}$, $TANH^{-1}$).

[SIN], [COS], [TAN] Trigonometric Function Keys
Used to calculate the respective trigonometric functions (SIN, COS, TAN).

[2nd F] [SIN⁻¹]
[2nd F] [COS⁻¹]
[2nd F] [TAN⁻¹]

Inverse Trigonometric Function Keys
Used to calculate the respective inverse trigonometric functions (SIN^{-1}, COS^{-1}, TAN^{-1}).

[→POL]

Rectangular to Polar Coordinates Conversion Key
Used to convert rectangular coordinates into polar coordinates.

[2nd F] [→REC]

Polar to Rectangular Coordinates Conversion Key
Used to convert polar coordinates into rectangular coordinates.

[2nd F] [n!]

Factorial Key
Used to calculate the factorial
$n! = n \cdot (n-1)(n-2) \ldots 2 \cdot 1$.

[nCr]

Combinations Key
Used to determine the number of possible combinations when selecting a specific number of items (r) from any number of different items (n).

[2nd F] [nPr]

Permutations Key
Used to determine the number of possible permutations when arranging a specific number of items (r) selected from any number of different items (n).

[2nd F] [→BIN]

Binary Number Mode Key
COMP mode:
Used to set the binary number mode. Also used to convert the number displayed into a binary number.

[2nd F] [→OCT] Octal Number Mode Key
COMP mode:
Used to set the octal number mode. Also used to convert the number displayed into an octal number.

[2nd F] [→HEX] Hexadecimal Number Mode Key
COMP mode:
Used to set the hexadecimal number mode. Also used to convert the number displayed into a hexadecimal number.

[2nd F] [→DEC] Decimal Number Mode Key
COMP mode:
Used to set the decimal number mode (normal mode). Also used to convert the number displayed into a decimal number.

[NEG] Negative Key
BIN, OCT, or HEX mode:
Used to obtain the negative complement of a number.

Hexadecimal Number Keys
HEX mode:

[A] Used to enter hexadecimal number A.
[B] Used to enter hexadecimal number B.
[C] Used to enter hexadecimal number C.
[D] Used to enter hexadecimal number D.
[E] Used to enter hexadecimal number E.
[F] Used to enter hexadecimal number F.

Logical Operator Keys
BIN, OCT, or HEX mode:

[NOT] NOT Key:
Used to enter logical operator NOT.

[AND] AND Key
Used to enter logical operator AND.

[OR] OR Key
Used to enter logical operator OR.

[XOR] Exclusive OR Key
Used to enter logical operator XOR (exclusive OR).

[XNOR] Exclusive NOR Key
Used to enter logical operator XNOR (exclusive NOR).

[(x, y)] Two Variable Data Designation Key
COMP mode:
Used to separate the x and y data during two variable statistical data entry.

[DATA] Enter Data Key
COMP mode:
Used to enter data in statistical calculations.

[2nd F] [CD] Correct Data Key
COMP mode:
Used to correct an error in statistical data.

Statistical Calculation Keys
COMP mode:

[RCL] [n] Used to obtain the number of samples (data) entered in statistical calculations.

[RCL] [Σx] Used to obtain the sum of x data entered in statistical calculations.

RCL Σy Used to obtain the sum of y data entered in two variable statistical calculations.

RCL Σxy Used to obtain the sum of the products for x and y data in two variable statistical calculations.

RCL Σx^2 Used to obtain the sum of the squares of each x data entered in statistical calculations.

RCL Σy^2 Used to obtain the sum of the squares of each y data entered in two variable statistical calculations.

RCL $\bar{x}$ Used to obtain the mean value of x data entered in statistical calculations.

RCL $\bar{y}$ Used to obtain the mean value of y data entered in two variable statistical calculations.

RCL σx Used to obtain the standard deviation σx of the population of x data entered in statistical calculations.

RCL σy Used to obtain the standard deviation σy of the population of y data entered in two variable statistical calculations.

RCL sx Used to obtain the standard deviation (sx) of the sample of x data entered in statistical calculations.

RCL sy Used to obtain the standard deviation (sy) of the sample of y data entered in two variable statistical calculations.

[RCL] [x'] Used to obtain the estimated value of x. (In the linear regression equation $y=a+bx$, the value of x is estimated from that of y.)

[RCL] [y'] Used to obtain the estimated value of y. (In the linear regression equation $y=a+bx$, the value of y is estimated from that of x.)

[RCL] [a] Used to obtain the constant a of the linear regression equation $y=a+bx$.

[RCL] [b] Used to obtain the coefficient b of the linear regression equation $y=a+bx$.

[RCL] [r] Used to obtain the correlation coefficient r between two variables (or data) x and y.

[2nd F] [1:] to [2nd F] [4:] Algebraic Expression Storage Area Number Keys
COMP mode:
Press to designate algebraic expression storage area and execute the program.
AER mode:
Press to designate the program entry area.

[ENT] Enter Key
AER mode:
Used to store a program (algebraic expression) in memory.

2nd F [▶] End Command Key
AER mode:
Used to terminate program execution. (These keys are used as the End command of an algebraic expression.)

Looping Keys
AER mode:

2nd F [↵] Used to specify the destination of a jump caused by the "⟵" command.

2nd F [⟵] Used to cause program execution to jump to the point where the "↵" command is located.

Compare Keys
AER mode:

2nd F [>] Used to determine if the magnitude of the left side of an expression is greater than that of its right side.

2nd F [≥] Used to determine if the magnitude of the left side of an expression is greater than or equal to that of its right side.

2nd F [≠] Used to determine if the left side of an expression is not equal to its right side.

Conditional Jump Destination Keys
AER mode:

2nd F [=Y▶[]] Used to specify the jump destination if the result of a conditional expression is "Yes".

2nd F [=N▶[]] Used to specify the jump destination if the result of a conditional expression is "No".

[2nd F] [,] Comma Key

AER mode:

Used to enter commas (,) which are used to separate two or more expressions or formulas in a program to be stored. If two expressions are separated by a comma, the result of the expression immediately before the comma will be displayed before proceeding to the following one.

[2nd F] [␣] Space Key

AER mode:

Used to enter spaces (␣) which are used to separate two or more expressions or formulas in a program to be stored. If two expressions are separated by a space, the expression immediately after the space is executed without displaying the result of the expression immediately before the space.

[f( )=] Variable Designation Key

AER mode:

Used to designate store memories (A to I, M, X, Y, Z) as the variables of an expression or formula. For example, when you press [f( )=] [ALPHA] [A] [ALPHA] [B] [f( )=] expression f(AB) = is entered and store memories A and B are designated as variables.

[BREAK] Break Key

COMP mode:

Used to interrupt the execution of an algebraic expression (i.e., program).

Appendix B
Calculation Range

- Range for entries and the four basic arithmetic operations, 1st and 2nd operands, and calculation results: $\pm 1 \times 10^{-99}$ to $\pm 9.999999999 \times 10^{99}$ and 0

Note:
When the absolute value of a numeric entry or the result of a calculation is less than 1×10^{-99}, this calculator regards the value as 0 (zero) for calculation or display.

Scientific and special functions

Function	Range
SINx TANx	DEG: $0 \leqq \lvert x \rvert \leqq 4.499999999 \times 10^{10}$ RAD: $0 \leqq \lvert x \rvert \leqq 785398163.3$ GRAD: $0 \leqq \lvert x \rvert \leqq 4.999999999 \times 10^{10}$ With TANx, however, an error occurs in the following cases: DEG: $\lvert x \rvert = 90(2n-1)$ RAD: $\lvert x \rvert = \frac{\pi}{2}(2n-1)$ GRAD: $\lvert x \rvert = 100(2n-1)$ (n: Integer)
COSx	DEG: $0 \leqq \lvert x \rvert \leqq 4.500000008 \times 10^{10}$ RAD: $0 \leqq \lvert x \rvert \leqq 785398164.9$ GRAD: $0 \leqq \lvert x \rvert \leqq 5.000000009 \times 10^{10}$
SIN^{-1}x COS^{-1}x	$-1 \leqq x \leqq 1$
TAN^{-1}x	$\lvert x \rvert < 1 \times 10^{100}$
LNx LOGx	$1 \times 10^{-99} \leqq x < 1 \times 10^{100}$
e^x	$-1 \times 10^{100} < x < 230.2585093$
10^x	$-1 \times 10^{100} < x < 100$

Function	Range
Y^x	• $y>0$ $-1\times10^{100}<x\cdot\mathrm{LN}\lvert y\rvert<230.2585093$ • $y=0$ $0<x<1\times10^{100}$ • $y<0$ $-1\times10^{100}<x\cdot\mathrm{LN}\lvert y\rvert<230.2585093$ Where x: integer, or $\frac{1}{x}$: odd number $(x\neq0)$
$\sqrt[x]{y}$	• $y>0$ $-1\times10^{100}<\frac{1}{x}\cdot\mathrm{LN}\lvert y\rvert<230.2585093$ • $y=0$ $0<x<1\times10^{100}$ • $y<0$ $-1\times10^{100}<\frac{1}{x}\cdot\mathrm{LN}\lvert y\rvert<230.2585093$ Where x: odd number, or $\frac{1}{x}$: integer $(x\neq0)$
$\sqrt[3]{x}$	$\lvert x\rvert<1\times10^{100}$
SINHx COSHx	$-230.2585093<x<230.2585093$
TANHx	$0\leqq\lvert x\rvert\leqq9.999999999\times10^{99}$
SINH^{-1}x	$0\leqq\lvert x\rvert\leqq4.999999999\times10^{99}$
COSH^{-1}x	$1\leqq x\leqq4.999999999\times10^{99}$
TANH^{-1}x	$\lvert x\rvert<1$
$\sqrt{x}$	$0\leqq x<1\times10^{100}$
x^2	$\lvert x\rvert<1\times10^{50}$
x^{-1}	$\lvert x\rvert<1\times10^{100}$ $(x\neq0)$
$n!$	$0\leqq n\leqq69$ (n: integer)
nPr	$0\leqq r\leqq n\leqq9999999999$ (r, n: integer) and $\frac{n!}{(n-r)!}<1\times10^{100}$
nCr	$0\leqq r\leqq n\leqq9999999999$ (r, n: integer) and $\frac{n!}{r!(n-r)!}<1\times10^{100}$ and $n-r\leqq69$ when $n-r<r$ $r\leqq69$ when $n-r\geqq r$
→POL	$\lvert x\rvert<1\times10^{50}$, $\lvert y\rvert<1\times10^{50}$ $x^2+y^2<1\times10^{100}$ $\lvert\frac{y}{x}\rvert<1\times10^{100}$
→REC	$0\leqq r<1\times10^{100}$ Same ranges as for trigonometric functions SINx and COSx apply to the angle θ ($x=r\mathrm{COS}\theta$, $y=r\mathrm{SIN}\theta$).

Function	Range
→DEG →D.MS	$\|x\| < 1 \times 10^{100}$
Conversions →DEC →BIN →OCT →HEX	Converted result: Integer DEC: $\|x\| \leq 9999999999$ BIN: $\underbrace{1000000000}_{\text{10 digits}} \leqq x \leqq 1111111111$ $0 \leqq x \leqq 0111111111$ OCT: $4000000000 \leqq x \leqq 7777777777$ $0 \leqq x \leqq 3777777777$ HEX: FDABF41C01 $\leqq x \leqq$ FFFFFFFFFF $0 \leqq x \leqq 2540BE3FF$
Binary/octal/ hexadecimal number calculations NOT	BIN: $1000000000 \leqq x \leqq 1111111111$ $0 \leqq x \leqq 0111111111$ OCT: $4000000000 \leqq x \leqq 7777777777$ $0 \leqq x \leqq 3777777777$ HEX: FDABF41C01 $\leqq x \leqq$ FFFFFFFFFF $0 \leqq x \leqq 2540BE3FE$
NEG	BIN: $1000000001 \leqq x \leqq 1111111111$ $0 \leqq x \leqq 0111111111$ OCT: $4000000001 \leqq x \leqq 7777777777$ $0 \leqq x \leqq 3777777777$ HEX: FDABF41C01 $\leqq x \leqq$ FFFFFFFFFF $0 \leqq x \leqq 2540BE3FF$
Other binary/octal/ hexadecimal number calculations	The ranges for entries and calculation results in each mode are the same as the above conversions.

Function		Range
Statical calculation	DATA CD	$\lvert x \rvert < 1 \times 10^{50}$ $\lvert y \rvert < 1 \times 10^{50}$ $\lvert \Sigma x \rvert < 1 \times 10^{100}$ $\Sigma x^2 < 1 \times 10^{100}$ $\lvert \Sigma y \rvert < 1 \times 10^{100}$ $\Sigma y^2 < 1 \times 10^{100}$ $\lvert \Sigma xy \rvert < 1 \times 10^{100}$ $\lvert n \rvert < 1 \times 10^{100}$
	$\bar{x}$	$n \neq 0$
	sx	$n \neq 0, 1$ $\lvert \Sigma x \rvert < 1 \times 10^{50}$ $0 \leqq \frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1} < 1 \times 10^{100}$
	σx	$n \neq 0$ $\lvert \Sigma x \rvert < 1 \times 10^{50}$ $0 \leqq \frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n} < 1 \times 10^{100}$
	$\bar{y}$ sy σy	Same as $\bar{x}$, sx, σx
	r	$n \neq 0$ $\lvert \Sigma x \rvert < 1 \times 10^{50}$ $\lvert \Sigma y \rvert < 1 \times 10^{50}$ $0 < (\Sigma x^2 - \frac{(\Sigma x)^2}{n})(\Sigma y^2 - \frac{(\Sigma y)^2}{n}) < 1 \times 10^{100}$ $\left\lvert \Sigma xy - \frac{\Sigma x \Sigma y}{n} \right\rvert < 1 \times 10^{100}$ $\left\lvert \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\sqrt{(\Sigma x^2 - \frac{(\Sigma x)^2}{n})(\Sigma y^2 - \frac{(\Sigma y)^2}{n})}} \right\rvert < 1 \times 10^{100}$

Function		Range
Statical calculation	b	$n \neq 0$ $\lvert \Sigma x \rvert < 1 \times 10^{50}$ $\lvert (\Sigma x)(\Sigma y) \rvert < 1 \times 10^{100}$ $0 < \left\lvert \Sigma x^2 - \frac{(\Sigma x)^2}{n} \right\rvert < 1 \times 10^{100}$ $\left\lvert \Sigma xy - \frac{\Sigma x \Sigma y}{n} \right\rvert < 1 \times 10^{100}$ $\left\lvert \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}} \right\rvert < 1 \times 10^{100}$
	a	Same as b, except the following $\lvert b\bar{x} \rvert < 1 \times 10^{100}$ $\lvert \bar{y} - b\bar{x} \rvert < 1 \times 10^{100}$
	y'	$\lvert bx \rvert < 1 \times 10^{100}$ $\lvert a + bx \rvert < 1 \times 10^{100}$
	x'	$\lvert y - a \rvert < 1 \times 10^{100}$ $\left\lvert \frac{y-a}{b} \right\rvert < 1 \times 10^{100}$

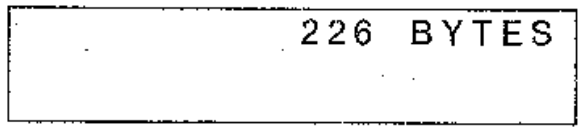
Note:
In the above calculation range, the calculation results or intermediate results are treated or displayed as 0 (zero) when their absolute values are less than 1×10^{-99}.

- As a rule, the error of functional calculations is less than ± 1 at the lowest digit of a displayed numerical value (the lowest digit of the mantissa in the case of scientific notation system) within the above calculation range. In the calculation of SINHx and TANHx, x is a singular point when it is 0 (zero). Near this point the error is accumulated, reducing the accuracy.

Appendix C
Check Remaining Memory

How To Check Remaining Memory

To confirm the number of bytes remaining in memory, press the [2nd F] and then hold down the [M.CK] key. The number of bytes remaining in the memory will be displayed. Example: 226 bytes



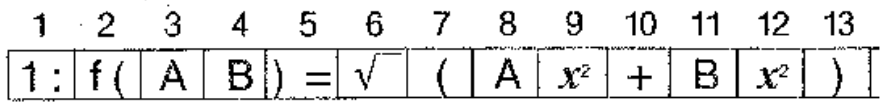
- Bytes are the units used for computer (or programmable calculator) memory or data size. With this calculator, one byte corresponds to one program step.

- When you store a number of programs (algebraic expressions) in memory, confirm the remaining bytes from time to time with this operation.

- If the memory becomes insufficient during entry of an algebraic expression, the cursor will start blinking and any further data entry will only replace the digit at the cursor. Either reduce the number of steps in the expression, or press the [ENT] key to enter the part of the expression you have input to that point, clear other unnecessary expressions from the memory, then continue inputting the remaining portion of the expression.

To Calculate the Number of Program Steps

Algebraic Expressions



For algebraic expressions, the total number of steps consumed is the sum of the input step count + 2 steps (for algebraic expression storage area number plus the ENT code).

The ENT code and algebraic expression storage area number code both occupy one byte of memory area. Therefore, one area can only store up to 158 steps with the remaining algebraic expression storage capacity.

Notes:

1. If the calculator displays "ERROR 4" when you specified an algebraic expression storage area 1: to 4: in the AER mode, this indicates memory overflow. Press the [CL] key to clear the error. Then either clear the contents of another algebraic expression storage area (see page 106) or reduce the steps by the number needed for the new steps.
2. If the calculator displays "ERROR 4" when you specified an algebraic expression storage area in COMP mode, this indicates that no algebraic expression is stored in the specified area.

Input Buffer Capacity in AER Mode

The calculator has an input buffer with variable length, so any expression input into this buffer may be stored into memory.

Notes:

1. When the remaining memory capacity is 160 bytes or more, input buffer capacity is limited to 160 bytes.
2. When the remaining memory capacity is less than 160 bytes, input buffer capacity is equal to the remaining memory capacity.

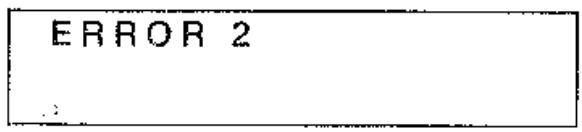
Appendix D
Error Conditions and Messages

Error Conditions

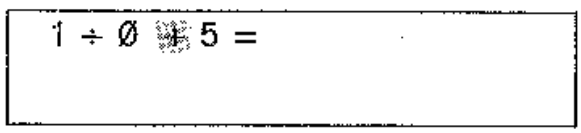
If you attempt to execute an operation exceeding the calculation range of the calculator, or if you attempt an illegal operation, the calculator will detect such an operation as an error condition and indicate the relevant error code and halt subsequent operations. To clear the error condition, press the [CL], [◄] or [►] key.

- If an error occurs, press the [◄] or [►] key and the location of the error will be indicated by a blinking cursor.

1 [÷] 0 [+] 5 [=]



[◄]



↑ Cursor blinks.

Error Messages

Code	Description of Error
ERROR 1	Syntax error (e.g., 3 [×] [+] 2) • Statistical data for single variable operation coexists with that for two variable operation.
ERROR 2	Calculation error: • Result of an operation, or the value of a pending operation, exceeds the calculation range of the calculator. (See Appendix B for the calculation ranges.)

- Division by zero was attempted.
- Numeric entry exceeds the input range of the function in a scientific calculation.

ERROR 3 Nesting error:

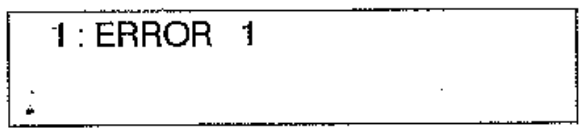
- Data or function exceeds the capacity of the 8-stage data buffer or the 16-stage function buffer.
- Attempt was made to execute a program in which more than 15 loops are nested.
- Attempt was made to display the calculation result of an expression more than 1,000 times.

ERROR 4 Memory error/overflow:

- Program (or expression) exceeds the memory capacity.
- Attempt was made up execute an empty storage area.

- If an error is found in a program (or expression) stored in the AER mode and executed in the COMP mode, the algebraic expression memory storage area number where the error has occurred will appear in the display, followed by the pertinent error code.

Example:



↑ Indicates that the error exists in memory storage area 1.

To review the errorneous location, press the [COMP] key. The location of the error with a blinking cursor will appear in the display while holding down the [◄] or [►] key.

Appendix E Priority Levels in Calculation and Pending Operations

Priority Levels

This calculator is provided with a function that decides the priority levels of individual calculations. Normally, the calculator permits you to perform the key operation of a given algebraic formula as written. The following shows the priority levels of individual calculations.

(1) (−)

(2) π, recall of memory contents, recall of answer memory

(3) Monomial function preceded by a number
(Example: x^2, x^{-1}, $n!$, →DEG, →D.MS, etc.)

(4) Binomial function
(Example: nCr, nPr, Y^x, $\sqrt[x]{\ }$, ➡POL, ➡REC, etc.)

(5) Multiplication where the × command is located immediately before a regular memory or before a monomial function followed by a number that has been omitted from entry.
(Example: 2π, 4A, etc.)

(6) Monomial function followed by a number.
(Example: $\sqrt{\ }$, e^x, 10^x, $\sqrt[3]{\ }$, LN, LOG, SIN, COS, TAN, ABS, INT, FRAC, NEG, NOT, etc.)

(7) ×, ÷

(8) +, −

(9) AND

(10) OR, XOR, XNOR

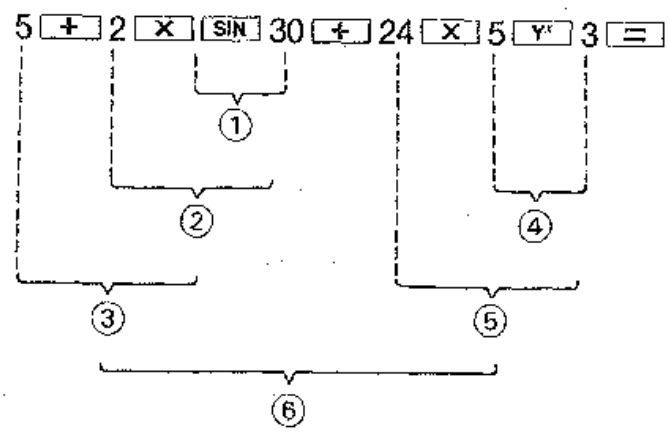
(11) =, M+, 2ndF M−, STO A to STO I, STO M, STO X to STO Z, ➡BIN, ➡OCT, ➡HEX, ➡DEC, ▶DEG, ▶RAD, ▶GRAD, ␣ (space), , (comma), DATA, CD, (x, y), x', y', $>$, $\geq$, $\neq$, ↵, ↩, ➡Y➡[ ], ➡N➡[ ], ⌫, etc.

- Parenthesized calculations have precedence over any other calculations.

- Provided that the functions shown in item (6) above are successively designated in an algebraic expression, calculations are performed from right to left.
  Example:
  e^xLN $\sqrt{\ }$ 120→ e^x {LN($\sqrt{\ }$ 120)}

- Other functions are calculated from left to right.
  Example:
  A $\sqrt[x]{\ }$ BY^{x}CY^{x}D → {(A $\sqrt[x]{\ }$ B)Y^{x}C}Y^{x}D

Order of calculation for a typical example:
Example:
5 + 2 × SIN30 + 24 × 5^3 =



Pending Operations

When the calculator performs calculations according to the established priority levels or performs a parenthesized calculation before any other calculations, the unit must suspend or set aside the calculation commands and numbers (or values) that cannot be processed immediately. For this reason, the calculator is provided with a memory area for pending operations, consisting of a 16-stage function buffer and an 8-stage data buffer. In other words, a maximum of 16 calculation commands and a maximum of 8 numbers can be stored in the memory area. An error condition occurs if this memory capacity is exceeded by pending operations.

Example 1:

Calculation with 8 pending numbers

$$1 + 2 \times (3 - 4 \div (7 \div 5 \sqrt[x]{\ } (7 \times 6 Y^x 3 =$$

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

$$14 - 5 + 4 \times \text{SIN2A}Y^x (2 + 3 \div \text{LOG3B} \sqrt[x]{\ } 48 =$$

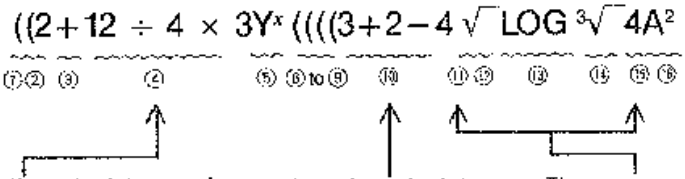
① ② ③④ ⑤ ⑥ ⑦⑧

When the calculator reaches the next "+" command, it executes 14 – 5 and holds the calculation result (9) in the data buffer.

A memory such as A or B is regarded as a number and is temporarily held in the data buffer.

Example 2:

Calculation with 16 calculation commands including parentheses



When the calculator reaches the × command, it executes the division 12 ÷ 4, with the result 3 ×.

When the calculator reaches the − command, it executes the addition 3+2, with the result 5−.

The × command was omitted from entry ($4 \times \sqrt{\ }$, $4 \times A^2$) but the calculator assumes the presence of the × command when executing the multiplication.

Appendix F
Battery Replacement

The calculator uses one lithium battery as its dc power supply.

Note on replacing the battery

When the battery is replaced, the memory contents are erased. Erasure can also occur when the calculator is defective or being repaired. Make notes of important contents of the memory as insurance against accidental erasure.

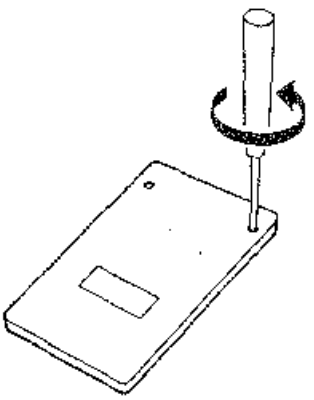
When to Replace Battery

If the indicators and numbers in the display (LCD) appear dim, it is a sign of low battery voltage. This means that the battery is nearing the end of its life. Replace the battery as soon as possible. Use of the calculator with exhausted battery may result in loss of the memory contents.

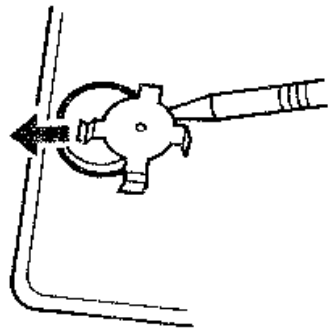
How to Replace the Battery

(1) Press the [OFF] key to turn off the calculator.

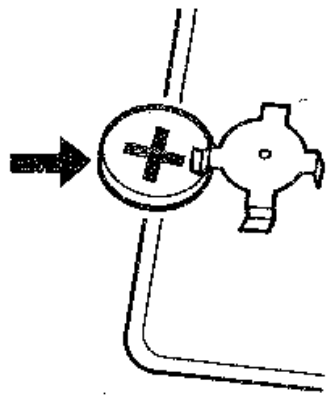
(2) Remove the both screws holding the back cover and remove the back cover.



(3) Remove the used battery with a ball point pen.

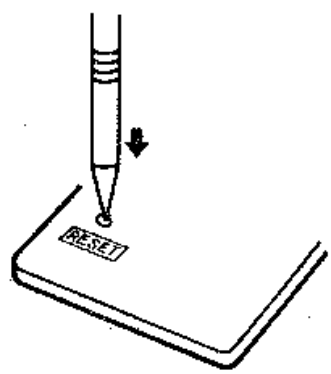


(4) Clean the replacement battery (CR2016) with a soft dry cloth, then place it with the positive (+) side facing up.



(5) Replace the back cover and secure it with the screws.

(6) Press the reset switch.



(7) Verify that the message "ALL CL?→ENT" appears on the display. If this message is displayed, press the [ENT] key. If this message does not appear, repeat steps (3), (4), (5), and (6).

Hints on Battery Use

1. Use only a lithium battery of the same type (CR2016).
2. When inserting the replacement battery, make sure the positive (+) side of the battery faces out of the calculator.

Cautions

- Incorrect handling may cause an explosion.
- Keep batteries out of reach of children.
- Dispose of the old battery safely. The battery may explode if placed in a fire.
- The original battery was installed upon shipment from the factory, so battery life may be shorter than that indicated in the Specifications.
- Remove the battery when it becomes exhausted or if the calculator is to be stored indefinitely, the battery may leak and cause damage.

Appendix G Specifications

Model	EL-512H
Calculation system	Algebraic expression (with priority decision function)
Memory	13 store memories (A to I, M, X, Y and Z, where M is also an independently accessible memory)
Display type	Upper line: Dot matrix liquid crystal (12 digits, 5 × 7 dots) Lower line: 7-segment display (10 digit mantissa and 2 digit exponent)
Display capacity/mode	Mantissa: 10 digits Exponents: 2 digits Display mode: Floating decimal point Fixed decimal point (FIX) Scientific notation (SCI) Engineering notation (ENG)
Calculations	Four basic arithmetic operations, trigonometric and inverse trigonometric functions, hyperbolic and inverse hyperbolic functions, conversion of angles, reciprocals, square roots and cubic roots, squares and powers, logarithmic and exponential functions, Xth roots of Y($\sqrt[x]{y}$), factorials, permutations, combinations, conversions of coordinates,

	memory calculations, statistical calculations, binary/octal/hexadecimal/ decimal number conversions and calculations, logical operations, absolute values, integer/fraction parts, modify, answer memory, etc.
Memory check function	Remaining memory (bytes) is displayed
AER functions	Variable designation, expression separation, end of command, conditional decision, and looping.
Calculation capacity	160 steps
AER capacity	256 steps
Display control function	Cursor left, cursor right, insert, and delete
Power supply	3V dc: Lithium battery (CR2016)
Power consumption	0.001W
Operating time	Approx. 800 hours continuous at 20°C (68°F) with 10 minutes operation/hour, 50 minutes display/hour
Operating temperature	0° to 40°C (32° to 104°F)
Dimensions	76(W) × 143(D) × 8(H)mm 3″(W) × 5-5/8″(D) × 5/16″(H) (without leatherette case)
Weight	100g(0.22lb)(including battery and leatherette case)
Accessories	1 lithium battery (installed) and operation manual